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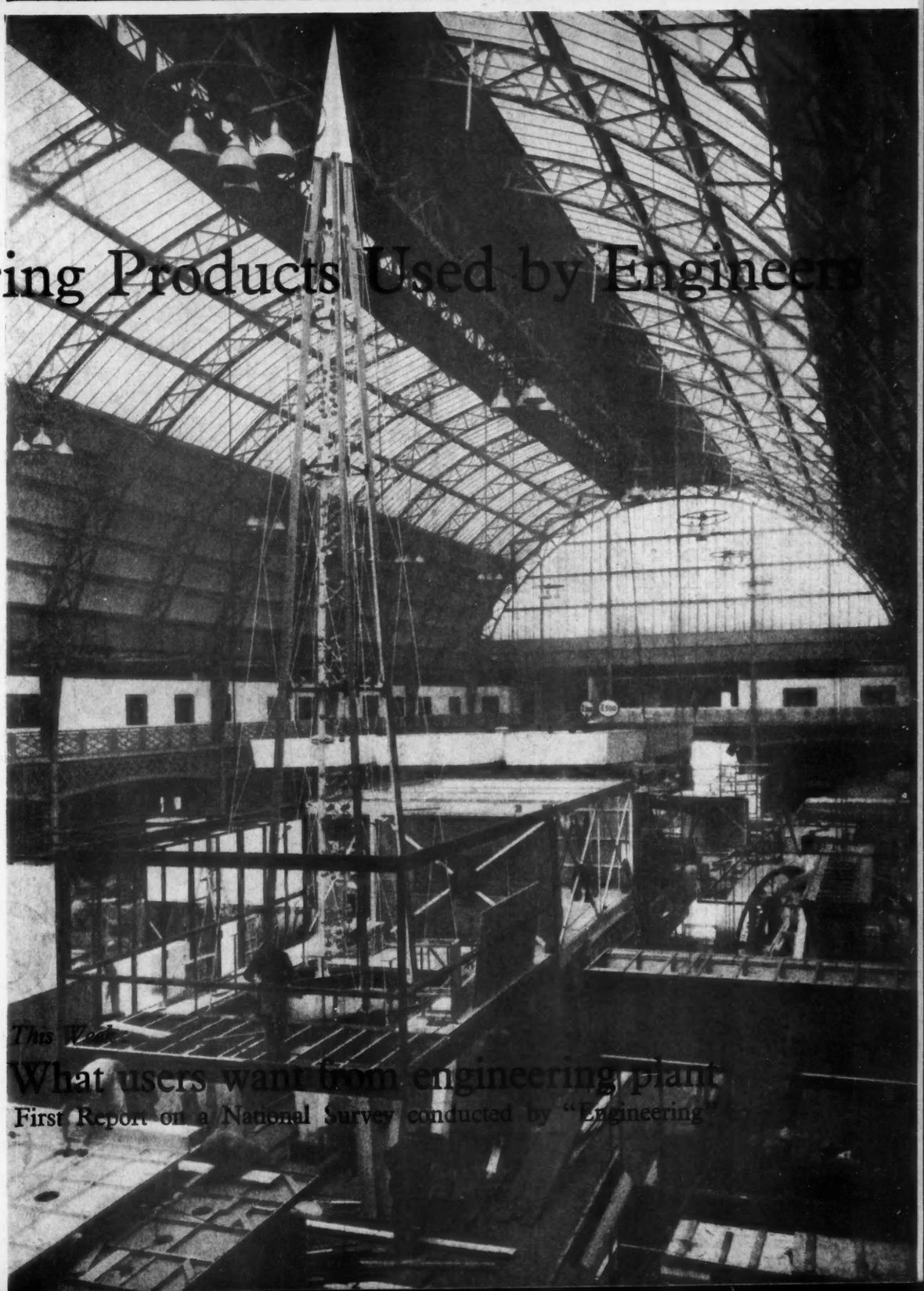

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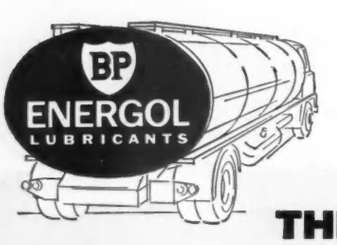

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Dams are built for governments, cars for individuals, harvesters for farmers, looms for textile manufacturers, pasteurising plant for dairymen. But a hard core of engineering products are used by engineers themselves—tools and equipment, plant and services ploughed back into the engineering industries. This seed crop will be widely represented at the Engineering, Marine, Welding and Nuclear Energy Exhibition, which opens at Olympia next Thursday, and provides the theme of this week's issue.

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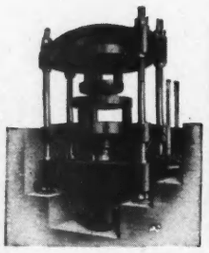

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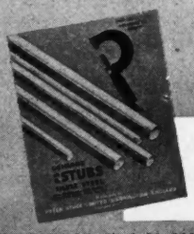

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ENGINEERING Impact

Of Falling First Cost in Nuclear Generation

ABUNDANT oil discoveries and the consequent fall in prices were as important a single factor as any other in the changing fuel supply position that upset the plans of four years ago for the building of nuclear generating installations. Now, after the stretching out of the programmes and the reduction of the number of consortia making up the United Kingdom's nuclear power station industry, it appears that changes in price may again be radically revising the prospects for nuclear generating stations.

Writing in *Moorgate and Wall Street*, the quarterly journal issued by Philip Hill, Higginson, Erlangers Limited, the merchant bankers, and Harriman Ripley Incorporated, the New York underwriters, Mr. Aldo Cassuto says: "Nuclear fuel costs may soon reflect the radical change in the uranium market position resulting from the world surplus of uranium oxide. This glut has become apparent since the Combined Development Corporation, on behalf of the British and United States Governments, gave up its options to renew existing overseas contracts at incentive prices. It is known that offers up to 50 per cent lower than the average official prices contracted for since 1952 are already available."

Uncertain Future

The way seems to be open for significant reductions in the initial fuel charges, an important part of the cost in any nuclear power station. Competition and the effects of over supply should bring down the cost of the fissile material which is the industry's foundation.

That the future of the peaceful application of nuclear energy, even with this apparent movement of events in its favour, is still highly uncertain is demonstrated by the recent Hawker Siddeley decision to close its experimental station at Langley, near Slough, outside London. The basic economic difficulty, that the small reactor has its likeliest application in the underdeveloped and sparsely populated nations, which are of course the least able to pay even the scaled down cost of the smaller unit, gets no nearer to solution. If the recommended United Nations plan to enable primary producing nations to insure against violent fluctuations in their overseas earnings comes to anything it may mean that such territories will be more willing to undertake the longer term economic planning, which could include power stations, nuclear or conventional.

Colour Television and the National Image

WITH some of the most advanced television equipment in the world, Associated Television have opened their new £4 million studios at Elstree, on the site of the former National film studios. Half an hour from being given the word, an ATV executive told ENGINEERING, the studio could be transmitting television programmes for reception on 625 line sets, the superior standard of definition used in a number of overseas television broadcasting countries. The new studios have all the ancilliary equipment that would be needed for colour transmission, all that would be required would be the installation of colour cameras.

But British television is compelled to wander along in monochrome and on the old, inadequate standard of definition while around the world the higher standard of definition is the normal; the United States and Japan have colour television services already operating.

One Japanese radio company, Tokyo Shibaura, intend to be producing 1,000 colour television sets a month by the end of the year. In Japan, where 108 television stations broadcast to seven million receivers, colour transmission has been going on since last September.

The cost of colour receivers, a Japanese 17 in set costs about £420, apart from other factors, indicates that there is perhaps no great export opportunity going begging there. But the company that can make the break through to cheap sets will be in a different position.

Overseas View

And there is the important trading consideration that a nation's standing in the eyes of the world is a mixture of historical and material, or technical achievement. In an age where many countries see the possession of a national television programme as a hallmark of emancipation, it is not sound exporting sense to leave a great technologically skilled competitor like Japan out in the van with a colour service while Britain remains perforce content with a not too precise grey and white.

How Many Engineers on 23 April?

TOMORROW (Saturday, 15 April) begins the distribution of the millions of forms on which will be recorded the 1961 census of the population of the United Kingdom. The War Office will be contributing not only its own sizeable slice of the population but the services of its computer at Worthy Down, near Winchester.

Whether for the calculations of industry or social workers, trade union leaders, civil servants, the universities or commerce, the basic facts elicited by the census are of increasing importance, with the growing number of the population and the complexity of the ways in which it spends its time.

Random Sample

This time (there have been 15 counts so far) the census forms will ask most people fewer questions than in 1951, the last occasion. Using the computer, there will be a saving of about two years in getting out the final conclusions. Simpler matters, such as population totals, should be known in a few months. The estimate of the Registrar General is that the population of England and Wales is now some 46 million, and that of Scotland 5·2 million. Ten years ago the respective populations were 43·8 million and 5·1 million.

Of outstanding importance for future decisions by industrial leaders, by those responsible for policy decisions in education and for many others will be the results worked out from the one-in-ten random sample who will be asked questions about education, occupation and scientific qualifications. Only such questions are to be asked as will give enough answers for the result to be reliable when multiplied for representation of the national position.

Census day itself is 23 April. The forms are to be collected in the following day. Whether by computer, or older methods, the four year calculations on what it all means will then begin. Four years is also the length of time spent in preparing the census. Without the computer the task of making all the necessary tabulations would go on so close to the next ten-year count that it might be doubted whether the results had more than academic interest. As it is the greater speed of the operation confers a new value on its results. It may even show how many people are employed in the manufacture and operation of electronic office machines.

of Advanced Performance Triumphing Against Odds

AGAINST all the gloomy forecasts on the future of the British-made car in the tough United States market, the United Kingdom's sports car makers have been rewarded with around £17 million worth of orders at the highly competitive New York international automobile show.

More than half of this total was placed with Jaguar Cars, whose new Jaguar E model gave the company, and British sports cars in general, the big filip that can only be brought off with real improvements in engineering and performance.

More than 4,000 sports cars were ordered from the British Motor Corporation, who succeeded in raising their share of the UK sports car market in the United States. International Standard-Triumph sold more cars at the show than they have ever done before. Rootes found that more than half of the increasing number of their sales were of the Sunbeam Alpine Series II sports car and the high performance Humber Super Snipe.

Up in the luxury class, almost half as many more Rolls Royces and Bentleys were sold compared with last year's New York show.

Family Cars Too?

For the sports car and the luxury limousine, the show points to a prosperous period in the American market. What is the lesson for the designers of the family car with its vastly larger market over the Atlantic—and its much fiercer competition? If, and it is perhaps the major question mark for the motor car industry, British saloon cars are to climb back to their former sales levels in North America, they will have to meet the American built compacts and overtake them in performance, design, lower first cost and be at least favourable in comparison on running costs.

This is not fundamentally a matter of sales promotion, though neglect of that function would be disastrous. The problems are rather those of the aluminium cylinder block, of the gearbox and the sensitive matter of suspension.

Jaguars—selling a car an hour throughout the nine-day New York show—and the sports car divisions of the bigger brothers have shown how surprisingly high sales can be made to go when performance and price catch the motorists' attention. Their family car colleagues may have a more leisurely product but the friendly struggle to show similarly increased sales will have nothing restful about it.

One of the facts of life in the United States car market has been the way in which, while the total sales of imported models have fallen, the Volkswagen has gone on its way, untroubled by the compacts.

But in the hazy pattern of the psychology of car purchase and use, a change seems inevitable.

A New Impetus in Technical Aid?

IF THE newly developing countries of Africa, Latin America and Asia are not to fall steadily further behind the rising standards of the older industrialised nations they need to be able to rely on a steady and growing volume of aid and cooperation.

Continuing and expanding Britain's contribution to the help given to the newly independent territories will be the opportunity and challenge to the Minister, when he is appointed, of the freshly created Department of Technical Cooperation. Any number of new departments will not free this question from the over-riding decision of the Treasury, nor from the even more inescapable truth that the United Kingdom cannot play a fuller part in helping overseas development until she is earning a large trading credit.

Sensitive Reaction

Meantime the new Department will ease the position in which, depending on their particular status overseas, territories dealing with Britain find themselves in contact with the Foreign Office, the Colonial Office and the Commonwealth Relations Office. To some extent the existence of a separate department will make it easier to call adequate attention to the United Kingdom's effort in overseas assistance, whether with money, staff or technical assistance. But the new minister will have the status of a Minister of State and will not be a member of the Cabinet.

Sensitive antennae among overseas states, whose goodwill and eventually whose trade we need as much as they now need economic help, will not fail to feel this. One result of this level of appointment is sure. The big guns of the Government, as of most governments, are members of the Cabinet. Yet the Minister for Technical Cooperation could have an influence in the Commonwealth, and indirectly on Britain's future prosperity, far exceeding that of the Ministers for Commonwealth Relations and the Colonies.

The present status to be given to the Minister for Technical Cooperation will tend to make his post one of those accepted as just another rung on the ladder. What is wanted from the first holder of the job is a successful drive to raise the level of the effort being made, the promotion of public awareness of the importance of overseas aid—and of foreign awareness of what Britain is doing, and the achievement of recognition of his job as a key post n its own right.

Corrosion Problems—and Four Solutions

Four examples where thick coatings—as distinct from solid linings—have been tried where painting a hand-prepared surface would not do.

A LITTLE under two years ago the firm of E. and F. Richardson, who make coating formulations at Buckingham, created a company called Coating Contractors. In their words at the time, this was done because "with the development of the more advanced types of coatings their application has become so specialized an operation that it falls outside the scope of the average contractor."

E. and F. Richardson still supply their so-called Adcora coatings to a number of contractors other than this firm, but Coating Contractors probably enjoy the closest technical liaison of any with their parent company. This article has been compiled from just four examples where Coating Contractors have applied Adcora coatings. You will notice that the coating thicknesses are all high—normally running into hundredths of an inch—which is getting on for ten times the normal thickness obtained with paints (other than the gelled varieties now obtainable). That is why Coating Contractors and their parent company refer to most of their coatings as high-build ones.

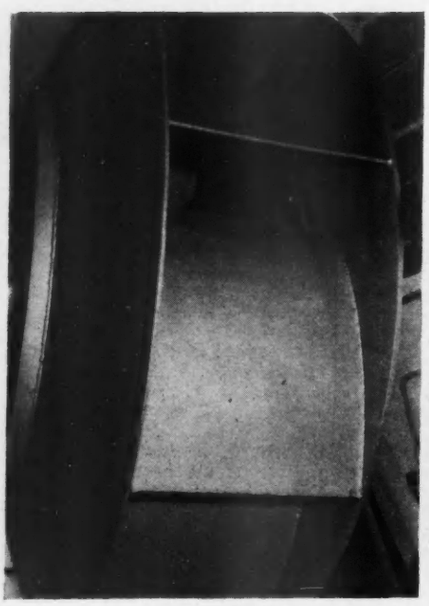
Surface preparation must be good, and this stage often accounts for the larger part of the total cost of a coating scheme. A note has been made in three of the examples of what was undertaken in this respect.

Coating Contractors Limited, Buckingham.

Fan Blades—Coal Tar/Epoxy

Protection was needed for runners and casings of 16 twin runner multivane fans for use in a synthetic fibre plant being installed overseas (see below). Water vapour permeability was to be low—and so was the cost. Diameters varied from 70 to 85 in.

The solution was to apply a polyamide cured coal tar/epoxy, Adcora A3 (SG), coating over a white blast-cleaned finish by a hot spray technique. The coating temperature at the spray gun orifice was 170° F resulting in a dry film thickness of 0·020 in for this application. The total area involved was about 15,000 sq. ft. Ducting for use with these fans is also being coated in a similar manner.



Centrifugal Pump—Neoprene

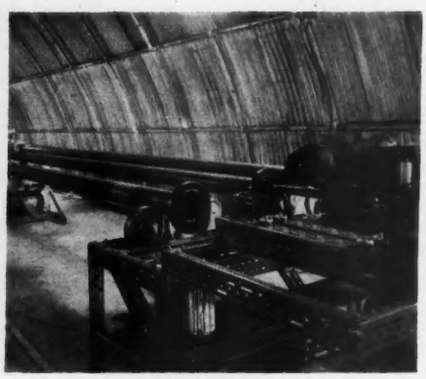
The 36 in ex-service centrifugal pump shown above, which handles esturine cooling water in a refinery near Southampton, needed protection against corrosion, erosion and graphitization.

A neoprene-based coating, Adcora P6, was chosen, for which the cast iron had to be well prepared. This was carried out by Coating Contractors after transport to Buckingham. First the surface was shot blasted to remove corrosion products and pockets of graphitisation. Then it was soaked in fresh water at 130° F to remove water soluble deposits, mainly chlorides engrained in pores of the metal. After drying at 100° F, the surfaces were shot blasted with 24 gauge crushed iron grit to produce a white finish. The prepared surface was tested by analysing the wash liquor. Finally, the pockets resulting from erosion and graphitization were made good with epoxy-based filler.

A multi-coat lining of neoprene was then applied to give a minimum thickness of $\frac{1}{16}$ in and was built up and reinforced with fibreglass laminate on the outwater to give an overall thickness of $\frac{1}{8}$ in. The completed lining was tested for thickness and continuity. Bond strength proved to be over 1,000 lb per sq. in.

Effluent Ducting—Neoprene

About 4,000 ft of 4 in bore steel pipe had to be given a seam-free lining to resist acidic trade effluent from a Middle East oil refinery. The pipe was in flanged lengths up to 25 ft and there were elbows and T's which also needed protection.



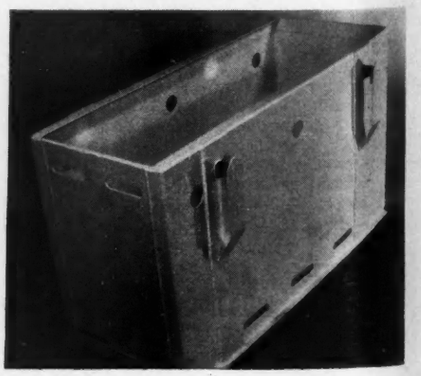
Coating Contractors applied a $\frac{1}{16}$ in thick lining of their neoprene-based material, Adcora P6, on a machine made for this purpose. This is shown in the illustration below and will handle lengths of up to 40 ft in diameters from 3 in upwards. Fittings were lined with the same material by hand.

Fuel Element Skips—Solventless Epoxy

A coating was needed to prevent corrosion of 1800 mild steel spent fuel element skips measuring 3 ft 10 in by 1 ft 6½ in by 2 ft 3 in deep. These would be used in cooling ponds at Hinkley Point nuclear power station, and whatever coating was chosen would have to provide a surface which could also be readily decontaminated of fission products.

The designers investigated heat-cured phenolic and similar coatings which, while satisfactory from a performance standpoint, all proved too costly for this unusually large number of skips. A wide range of epoxy resin based paints and coatings were then tested and, though economical, all but one failed to give the desired performance either mechanically or chemically. The good one was a solventless epoxy coating made by E. and F. Richardson. This Adcora SP was applied to a thickness of 0·015 in by Coating Contractors and proved to be satisfactory in these tests for corrosion, impact strength and decontamination of fission products.

The illustration below shows such a skip coated with white solventless epoxy over a blast cleaned substrate, with a coating thickness of 0·015 in ± 0·003 in.



Filled Polyester Insulation Material

Rosite is the name given to a family of insulation materials made by a company of the same name. The original material made by them was a resin impregnated asbestos cement. Their latest is a glass reinforced polyester moulding compound to which has been added mineral fillers to give it better heat resisting properties than previous grades.

Called Rosite 3250, this material is made by a hot moulding technique which yields properties such as those shown below. The company comment from these that the dielectric and mechanical strength are improved, that dimensional accuracy is good and that resistance to moisture absorption is improved. Arc quenching, arc resistance and non-tracking qualities are also said to be as good as in other Rosite grades.

Rosite Limited, Cheney Manor, Swindon, Wilts.

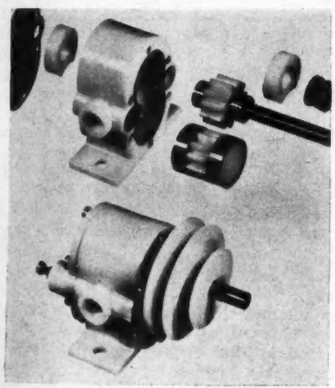
Dielectric strength	300 volts per mil
Dielectric constant	3·25
Dissipation factor at 1 kc/s	0·041
Dissipation factor at 1 Mc/s	0·022
Flexural strength	10,000 to 12,000 lb per sq. in
Impact strength (depends on glass content)	Izod 2 to 8 ft-lb
Compressive strength	20,000 to 25,000 lb per sq. in
Specific gravity	2·1
Flammability	self extinguising
Ignition time	3½ minutes
Arc resistance (depends on glass content) ASTM	180 to 240 sec
Water absorption, 24 hr	0·1 per cent

Acetal Plastic in Gear Pump

An American firm has designed a gear pump which makes extensive use of Delrin, the acetal plastic made by Du Pont. The most important parts of this, other than a spring loaded bypass valve in the end housing, can be seen in the illustration. The makers are Planet Products of Chicago, Illinois.

These pumps have a capacity claimed to be up to 18·5 gallons a minute working at pressures from zero to 100 lb per sq. in. Tests performed by an independent laboratory are reported by Du Pont to have shown that the plastic design reduces horsepower requirements by as much as 50 per cent compared with conventional pumps made of metal.

There are several patented design features in this pump. A ball bearing unit inserted in the



drive sheave is supported by the housing through the external hub on the front plate. The gears of Delrin have integral hubs over which a thin metal sleeve is pressed, and, presumably to reduce bearing loads, the bearing areas are four times greater than would be normal. The drive gear's hub runs in bushings of Delrin, while the hub of the idler gear rotates in the actual housing cavity, thus eliminating the normal shaft for the idler gear and requiring no recessed bearings in the front or rear end plates. An internal bypass is injection-moulded as part of the end plate, and spring-loaded valve seats of Delrin are claimed to provide accurate control of bypass flow and pressure.

Du Pont Information Service, 81 Route de l'Aire, Geneva, Switzerland.

Tungsten Carbide for Turning Steel

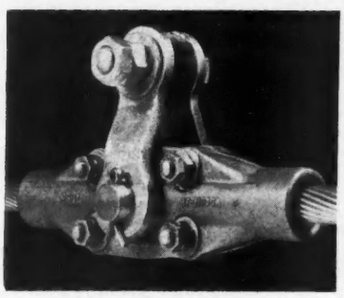
Sandvik Steelworks Company in Sweden have developed a new grade of tungsten carbide which is claimed to have better abrasion and cratering resistance than grades presently available. This results, say the company, from the higher than normal content of titanium and tantalum carbides.

Because of its wear resistance, this S1 Premium is thought by the makers to be of most use in machining steel and steel castings where at least 30 to 40 per cent more pieces per cutting edge can normally be expected. In this country it is available as tips, inserts, turning tools, shell end mills, cutter blades and other forms.

Sandvik Swedish Steels Limited, Halesowen, Birmingham.

Aluminium Suspension Clamp

Alcan Industries claim that a new design of aluminium suspension clamps for overhead transmission lines, which they have recently introduced, overcomes many of the disadvantages associated with the traditional style of clamp. It consists of two matching halves that when brought together enclose the conductor and grip it with the correct degree of tightness. Thus the clamp cannot be overtightened, as is possible with the old style, and damage to the



conductor strands from this cause is eliminated.

The more usual malleable iron clamps say, Alcan, are well known to give rise to hysteresis and eddy-current losses which, apart from loss of power involved, may cause sufficient heating of the clamp to drive out the protective grease surrounding the core of the conductor, and in extreme cases may even have an annealing effect.

In the new design, the axis of the side trunnion is level with the conductor centre line, which ensures that any pivoting motion will have the least possible effect on the conductor, this being a requirement specified by the Central Electricity Generating Board. Alcan add that field tests have been very promising.

Alcan Industries Limited, Banbury, Oxon.

Pvc/Polyester Ducting

In last week's issue of ENGINEERING there was an article which showed some five uses of Tufplas—basically fabricated rigid pvc strengthened with glass reinforced polyester. In that article it was mentioned that a firm of resin makers offered a system which was similar in the final look of the product. Here is a product made with the materials offered by this firm. Tanks and Linings of Droitwich are using the system offered by Artrite Resins.

Ducting produced for a firm of platers in the Midlands has been made by fabricating rigid pvc ⅛ in thick and covering this with glass reinforced polyester. On the outer side Tanks and Linings have put a coating of their Nutracote, which is a vinyl paint. About this installation, shown here, Tanks and Linings comment that, though measuring 10 ft by 5 ft at one section of the ducting, the pvc was only ⅛ in thick, and even so, full rigidity and impact strength has been maintained by the glass reinforced polyester resin. They do not quote figures for strength and adhesion—which are two of the features emphasised by Tough Plastics—but even if they are low, this may not in all cases be a disadvantage. For this fume ducting, for instance, which will handle gases from the tops of a line of pretreatment and plating baths (mainly acidic), there is unlikely to be much thermal cycling to put a strain on the interlayer adhesion. And the company add that there are no formed pieces of pvc which might

try to revert to the unformed shape and so put further strains on the adhesion.

Tanks and Linings Limited, Town Wharf, Hanbury Road, Droitwich, Worcestershire.

Reinforced Plastics — Book of Practice

British Resin Products have asked three of their staff men to write a book summarising the state of the art in making glass reinforced polyester mouldings. This is now published under the title *Cellobond Polyester Resins, Technical Manual No. 12*, and can be obtained free from the company by people who have a genuine interest in the subject (230 pp., ill).

This book is a very sane trade publication and deserves more careful consideration than would one whose sole aim was to boost a particular brand of resins. The authors' acknowledged aim—when not talking formulations—has been to discuss moulding practice generally.

There is a piece of very cool advice at the end of the sixtieth page, and it is pleasing to note a sensible approach to where glass reinforced plastics should be used rather than the use-it-regardless attitude. "It should be remembered," say the authors, "that to design a component in reinforced plastics rather than some conventional material cannot be justified unless there is some important, compensating advantage to be gained from so doing." You might wonder to whom this is addressed—whether to the person who is already established as a moulder in the industry, or to the prospective moulder who might read this book and sink his capital. Undoubtedly it is addressed to both. One can confidently expect that both sorts of reader will get through the book without losing interest or getting mental indigestion. There is down-to-earth advice for the newcomer including a glossary of terms and a list of suppliers of raw materials with their addresses. For those already in the trade there is talk on formulations as well as four chapters on factory management which should be useful for the man who is expanding his business.

British Resin Products Limited, Devonshire House, Piccadilly, London, W1.

Plain Words

By Capricorn

I OFTEN get depressed at the sheer volume of information that has to be absorbed from daily papers, journals and magazines. There are new periodicals on technical subjects constantly appearing and those already established seem to be growing larger. The serious Sunday newspapers are a typical example of the current invitation to a surfeit of the printed word.

The problem is developing so rapidly that I am becoming little better than a headline and title scanner. Then I catch myself out in some serious omission of reading and I try the more systematic approach of making different piles of papers.

I have a heap which are urgent and which must be read, or skimmed through. Then I keep a pile concerned with subjects on which I tell myself I must be up to date, because they are my own field and if I fail to keep abreast in that small area, I might as well give up. Then there is a third heap which I mark up for my colleagues. Finally, there is a large and growing heap of papers which I have set aside to read "some day." But "some day" rarely comes.

There seems to be no way out of it at all. Yet perhaps technical information is the most basic raw material of engineering—the engineering product most used by engineers. How can we learn to cope with it? I take some periodicals to read in trains. I use the duller ones as soporifics. I dream, but with little hope, of devising some simple system of precis-making (which I could patent and hire to others afflicted like myself).

The trouble about summaries and digests is that except in certain new branches of engineering where there is still a coherent body of knowledge which the specialist can readily assimilate, we only read to keep our backgrounds up to date or to spot those suddenly illuminating pearls of information germane to our responsibilities. But no two backgrounds or responsibilities are quite the same. The man who makes the digest may consider one group of facts significant, and I another.

For the same reason, I have never really found it satisfactory to have items marked for my attention. They either prove to be slightly off my beat, frustratingly incomplete or so ill-defined that I must spend more time in reading them (to find a single grain of truth perhaps) than I can really spare.

We are indeed being forced to read faster and faster, more superficially and more slovenly. I don't think those special reading courses, much publicised some while ago, are quite the answer. More comprehension per unit time is an admirable ideal, but the brain has its own speed of working and will only make sense of the data it receives after mulling over and assimilation.

Roll on my holiday, when I shall retreat beyond the reach of print and paper. Or should I risk the anger of my wife and take the pile marked "some day"?

Letters to the Editor

Solar Energy Claims

SIR, The article "New Scope for Utilising Solar Energy" by Stephen A. Vincze (ENGNG., 16 Dec. '60, p. 824) contains a number of statements that seem to me to badly need support. In particular, what is the source of information for the sentences: "In Australia, North Africa, Italy and the United States about 15,000 people depend on solar distillation plants for their drinking water. It is planned to heat several million buildings by solar means in the USA"? I have contacted the Association for Applied Solar Energy and they, too, are interested in learning of substantiating evidence. Regarding the planned millions of solar buildings, the President of the Association wrote: ". . . our up-to-date information shows that no such plans are in existence."

Mr. Vincze's article cites not one single reference, although apparently he used some because his Fig. 2 seems to have been taken from Professor Hoyt Hottel's article "Residential Uses of Solar Energy" presented at the World Symposium on Applied Solar Energy, held at Phoenix in 1955. The figure appears on p. 105 of the published proceedings. Similarly reproduced by Mr. Vincze without credit is his Fig. 4 of a solar cooker developed in India, which appears in Nathan Robinson's paper, on p. 58 of the *Phoenix Proceedings*, and his Fig. 6, of a solar power station, which appears in V. A. Baum's paper on p. 298 of the *Phoenix Proceedings*.

Mr. Vincze concludes his article with the sentence: "The above figures reveal that solar heating plants are both technically and economically feasible, particularly for commercial and industrial installations." Both the figures and the revelation seem to me to require considerable elucidation and justification, since the solar houses about which we have been reading for the past few years are reported to have been much too costly to compete economically with conventionally heated houses.

I would like to take this opportunity, also, to ask about the verification of statements made in the article "All Run by Sunshine" (ENGNG., 10 June '60, p. 804). Mr. Hickinbotham raised some questions about it in the issue of 14 October, and was answered by some "simple facts" stated by Mr. Capps in the issue of 28 October. When scientists disagree, the usual recourse is to experiment rather than to snide remarks about "tolerance" and "other sociological systems" and requests for "better assurance of Mr. Hickinbotham's capabilities as a scientist before discussing." The question remains: How has the "self-contained 1·2 acre estate" worked out?

I am specially interested in the statement that "storage of the heat from the sun during the summer for use in the winter . . . has been solved by using a sufficiently large volume of earth below the actual building." My own calculations, published in *Solar Energy*, issue of December, 1959, indicate the contrary, as does the experience of Bridgers and Paxton in their solar heated office building in New Mexico. "All Run by Sunshine" ends with a reference to "Mr. Martin Capps . . . (who) carried out the theoretical heat balance calculations as his thesis for a higher degree." A number of us working on solar energy problems would like to see these calculations. Can they not be published, at least in summary form? If valid, they represent a "break through" of greatest interest.

Solar energy has been welcomed with perhaps *too* much enthusiasm in some quarters, and has received "favourable" publicity which does harm. Who is going to invest time and money in research on problems that are ballyhooed as already solved and ready to be embodied in commercial products? Who is going to work to achieve a break through that has been announced before he starts work? This is the first time, however, that I have seen a reputable technical journal come under suspicion in this regard. I think a number of your readers would appreciate having the two articles under question either backed up with cogent evidence or else apologised for and mis-statements rectified.

Sincerely yours,

EDWARD SPEYER,
Senior Research Physicist.

American Machine and Foundry Company,
Research and Development Division,
Springdale, Conn., USA.
28 March, 1961.

Editor's Note: As limitations on space obliged us to omit the bibliography of Mr. Vincze's article, we apologise for the absence of credits.

Designer and Writer

SIR, Mr. P. C. Taylor is quite right in his letter to the Editor (ENGNG., 7 April, p. 476), especially in his references to engineering studies in London schools. (See also ENGINEERING Impact, 17 March '61, p. 373, "Engineering Studies in London Schools.")

Much could be done in schools for the discovery and development of latent creative talent, by more attention to drawing and sketching. Not so much mechanical or engineering drawing, but just drawing as such, with no nonsense about "Art" mixed up with it.

Intelligent (and intelligible) descriptive writing deserves plenty of attention, but drawing is the engineer's—or architect's—ONLY medium of transfer from thought to material.

Yours faithfully,

HUGH CLAUSEN.

London, NW2.
10 April, 1961.

Events in Advance

Future Congresses on Combustion Engines

PLANS for next year's International Congress on Combustion Engines (the sixth of the series) will include the holding of no fewer than six double technical sessions and three works visits.

The congress will take place in Copenhagen, Denmark, from 18 to 23 June, 1962, and is being organized by the permanent committee of the International Congress on Combustion Engines (CIMAC). As its theme, the congress will discuss "recent developments with diesel engines and gas-turbines above 3,000 horsepower per engine and with gas engines above 1,500 horsepower per engine." The date for the submission of papers has now passed and synopses have already been approved by the permanent committee.

Further details of the programme and enrolment procedure for the Copenhagen congress are expected to be made available towards the end of this year.

Tentative arrangements for the following International Congress on Combustion Engines (the seventh of the series) have also been discussed and it has been agreed that this event shall be held in the United Kingdom, probably during the summer of 1965. All inquiries in the United Kingdom regarding either congress should be addressed to the British national committee, International Congress on Combustion Engines, 6 Grafton Street, London, W1. (Telephone: HYDe Park 5107). The honorary secretary to the British committee is Mr. Malcolm Logan, T.D., M.A.

Traction Engine Rally at Birmingham

FOLLOWING upon the success which attended a similar event last year, the Birmingham City Museum has decided to hold another traction engine rally on Sunday, 14 May next, in Newhall Street, outside the museum.

Several entries have already been received and

there is every prospect that the authorities will be able to provide a wide variety of demonstrations. The rally will be coupled with the running of a number of engines on steam inside the museum. In addition, there will be film shows of general engineering interest.

The rally will be held from 12 noon until 5 p.m. and, for that day only, the museum will be open during the same period. Additional details may be obtained from the keeper, Mr. N. W. Bertenshaw, B.Sc.Tech., City Museum and Art Gallery, Newhall Street, Birmingham 3, or by telephoning Birmingham Central 1022.

British Aid for Turin Labour Exhibition

MANY nations, including the United Kingdom have accepted invitations to participate in an International Labour Exhibition which is to be held in Turin, from 1 May to 31 October next, as part of the centenary celebrations which are being organized to commemorate the unification of Italy.

Turin has been chosen by the Italian organizers as the site for these celebrations by virtue of the outstanding and historic part played by the city at the time of the Risorgimento.

To represent them at the exhibition, the British Government have appointed Mr. Anthony C. Kendall, C.B.E., formerly British consul in Venice, as commissioner-general, and Mr. Cecil Cooke, C.M.G., director of the exhibitions division, Central Office of Information, as deputy commissioner-general.

The British contribution has been designed and produced on behalf of the Foreign Office by the Central Office of Information and will portray the progress which has been made in the field of scientific research during the past hundred years. United Kingdom inquiries concerning this event should be addressed to the Central Office of Information, Hercules Road, Waterloo Bridge Road, London, SE1. (Telephone: WATerloo 2345, extension 245.)

Exhibitions and Conferences

Stainless Steel Exhibition.—Commenced Wed., 8 Mar. and will continue until Thurs., 4 May, at the Mayfaria Rooms, Marble Arch, London, W1. Sponsored by the Stainless Steel Manufacturers' Association, 4 Milbourne Avenue, Sheffield 10. Tel. 63291.

Organic Semiconductors, Conference.—Tues. and Wed., 18 and 19 April, at the Morrison Hotel, Chicago. Organised by the Illinois Institute of Technology, 35 West 32nd Street, Chicago 16, Illinois, USA.

Institution of Plant Engineers, Annual Conference.—Wed., 19 April, to Fri., 21 April, at the Imperial Hotel, Blackpool. Organised by the Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. Tel. SLOane 0469.

Aslib Electronics Group Conference.—Fri., 21 April, to Sun., 23 April, at Ashridge. Apply to the secretary, Aslib, 3 Belgrave Square, London, SW1. Tel. BELgravia 5050.

Institution of Agricultural Engineers, One-Day Conference.—Tues., 25 April, at the Piccadilly Hotel, 21 Piccadilly, London, W1. This event will include the Institution's annual general meeting and an informal dinner. Institution's offices: 6 Queen Square, London, WC1. Tel. TERminus 0140.

Packaging and Package Handling Exhibition, International (MACROPAK).—Tues., 2 May, to Tues., 9 May, in the new RAI Building, Amsterdam. Organised by N.V. 't Raedthuys, 5 Tesselschadestraat, Amsterdam-W, Netherlands.

Railway Modernisation Conference.—Wed. and Thurs., 3 and 4 May, at the Institution of Civil Engineers. Organised by the Institutions of Civil, of Mechanical, and of Electrical Engineers. Applications may be made to the Institution of Mechanical Engineers or the Institution of Electrical Engineers; or to the secretary, Institution of Civil Engineers, Great George Street, London, SW1. Tel. WHItehall 4577.

British Columbia International Trade Fair.—Wed., 3 May, to Sat., 13 May, in Vancouver, British Columbia. Apply to the Agent General for British Columbia, 1 Regent Street, London, SW1. Tel. WHItehall 6857.

Industrial Finishes Exhibition, First International.—Mon., 8 May, to Thurs., 11 May, at Earls Court, London, SW5. Organised by the Exhibition Division, Scientific Surveys Ltd., 97 Old Brompton Road, London, SW7. Tel. KNIghtsbridge 9360.

Measurement, Control, Regulation and Automation, International Exhibition.—Tues., 9 May, to Wed., 17 May, in the Exhibition Hall of the Centre National des Industries et des Techniques, Paris. Exhibition offices: 40 Rue du Colisée, Paris 8e.

Materials Handling, Second International Conference.—Wed., 10 May, to Fri., 12 May, at the Prince of Wales Hotel, Southport. Organised by the Institute of Materials Handling, 32 Watling Street, London, EC4. Tel. CITy 7045.

Institution of Locomotive Engineers, Golden Jubilee Celebrations.—Wed., 10 May, to Fri., 12 May, in London. Offices of the Institution: 28 Victoria Street, London, SW1. Tel. ABBey 6672.

NOMA International Conference and Office Exposition.—Sun., 7 May, to Thurs., 11 May, in St. Louis, Missouri. Organised by the National Office Management Association, Willow Grove, Pennsylvania, USA.

Institution of Electrical Engineers, Summer Meeting.—Mon., 29 May, to Fri., 2 June, in London. Offices of the Institution: Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Radio and Electronic Component Show.—Tues., 30 May, to Fri., 2 June, at Olympia, London, W14. Apply to Industrial Exhibitions Ltd., 9 Argyll Street, London, W1. Tel. GERrard 1622.

Institution of Heating and Ventilating Engineers: Summer Meeting.—Wed., 7 June, to Fri., 9 June, at Torquay. A post-conference tour on Sat., 10 June, will be arranged if there is sufficient demand. Offices of the Institution: 49 Cadogan Square, London, SW1. Tel. SLOane 3158.

Institution of Mechanical Engineers, Summer Meeting.—Mon., 19 June, to Thurs., 22 June, in Glasgow. Offices of the Institution: 1 Birdcage Walk, St. James's Park, London, SW1. Tel. WHItehall 7476.

Instrument Show, Sixth International.—Mon., 19 June, to Fri., 23 June, at 4 Tilney Street, London, W1. Organised by B and K Laboratories Ltd., 4 Tilney Street, London, W1. Tel. GROsvenor 4567.

Levant Fair, 25th International.—Sun., 3 Sept., to Mon., 18 Sept., at Bari. Agent in the United Kingdom: Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Electronic Counting Techniques": symposium, comprising the following papers—"Trochotron High-Speed Beam Switching Tubes," by D. Reaney; "A Self-Indicating Magnetic Scaling System, Using Electro-Deposited Nickel-Iron Film Cores," by Dr. E. Franklin; "Transistor Counting Techniques," by F. H. Wells; and "The Tunnel Diode in Counting Circuit Applications," by I. Aleksander. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 26 April, 6 p.m.*

Chemical Society

ST. ANDREWS
"Chemistry of Photography," by J. M. Taylor. St. Andrews and Dundee Branch. Joint meeting with the University of St. Andrews Chemical Society. Chemistry Department, St. Salvators College, St. Andrews. Fri., 28 April, 5.15 p.m.

Illuminating Engineering Society

LEEDS
Annual General Meeting. Leeds Centre. Guildford Hotel, The Headrow, Leeds. Mon., 8 May, 6.30 p.m. (To be followed by a buffet supper.)

Institute of Marine Engineers

BIRMINGHAM
"History and Development of Air and Gas Compressing Plants," by M. J. Waldron. West Midlands Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Thurs., 27 April, 7 p.m.

Institute of Road Transport Engineers

LIVERPOOL
Annual General Meeting. North Western Centre. Merton Hotel, Merton Road, Bootle, Liverpool 20. Thurs., 27 April, 7.30 p.m.

Institution of Civil Engineers

LONDON
"Auckland Harbour Bridge: Design," by Gilbert Roberts and O. A. Kerensky; and "Auckland Harbour Bridge: Construction," by H. Shirley Smith and J. F. Pain. Tues., 9 May, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Artificial Muscles": Discussion, to be introduced by Dr. A. B. Kinnear Wilson. Medical Electronics Discussion Group. Fri., 5 May, 6 p.m.*
"The Corona-Discharge and Its Application to Voltage Stabilisation," by E. Cohen and Dr. R. O. Jenkins; "Impedance Frequency Characteristics of Glow-Discharge Reference Tubes," by Dr. F. A. Benson and P. M. Chalmers; and "Comparison of Argon, Krypton and Xenon as Admixtures in Neon Glow-Discharge Reference Tubes," by Dr. F. A. Benson and G. P. Burdett. Electronics and Communications Section. Mon., 8 May, 5.30 p.m.*
"Electricity Supply in India and Its Future," by Dr. M. Datta. Supply Section. Wed., 10 May, 5.30 p.m.*
ABERDEEN
Annual General Meeting. North Scotland Subcentre. Robert Gordon's Technical College, Aberdeen. Fri., 12 May, 7.30 p.m.
GLASGOW
Annual General Meeting. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Wed., 10 May, 6 p.m.
MANCHESTER
"The Protection of High-Voltage Systems from Lightning Faults," by Dr. R. H. Golde. Annual General Meeting. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 9 May, 6.15 p.m.

Institution of Electronics

BIRMINGHAM
"Tunnel Diode Circuit Applications," by I. Aleksander. Birmingham Branch. New College of Technology, Gosta Green, Birmingham 4. Thurs., 18 May, 7 p.m.

Institution of Engineering Inspection

CRAWLEY
"Drop Forging Techniques," by W. H. Eaton. Crawley Group. Crawley College of Further Education, Crawley. Thurs., 11 May, 7.30 p.m.

Institution of Plant Engineers

LONDON
"Paints and the Preservation of Steel," by E. W. Marshall. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 2 May, 7 p.m.*
MANCHESTER
"The Moon," by Dr. G. Fielder. Manchester Branch. Manchester Literary and Philosophical Society, George Street, Piccadilly, Manchester. Tues., 9 May, 7.15 p.m.
PETERBOROUGH
Various short papers by members. Peterborough Branch. White Lion Hotel, Church Street, Peterborough. Tues., 2 May, 7.30 p.m.
SOUTHAMPTON
"Industrial Floors," by W. J. Warlow. Southern Branch. Polygon Hotel, Southampton. Wed., 3 May, 7.30 p.m.

Institution of Production Engineers

CARDIFF
"Conservation of Materials." One-day regional conference. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 5 May, 9 a.m. to 4.30 p.m. (Tickets required: apply to Mr. A. E. Haynes, c/o A. B. Metal Products Ltd., Abercynon, Glamorgan.)

Institution of Structural Engineers

LONDON
"Composite Construction in Theory and Practice," by Professor Dr. Ing. Konrad Sattler. Thurs., 27 April, 6 p.m.*

Royal Aeronautical Society

LONDON
Annual General Meeting. Thurs., 4 May, 6.30 p.m.
"Transport Rotorcraft Design Trends," by R. Hafner. Rotorcraft Section. Fri., 5 May, 7 p.m.

Royal Institution

LONDON
"Colourise the Natural Image," by Edwin H. Land. Fri. 28 April, 9 p.m.

Royal Society

LONDON
"Cyclotron Resonance Over a Wide Temperature Range: I Germanium; and II Silicon," by D. M. S. Bagguley, R. A. Stradling and J. S. S. Whiting. Thurs., 4 May, 4.30 p.m.*

Royal Society of Arts

LONDON
"The Future Pattern of University Education in the United Kingdom," by J. S. Fulton. Wed., 10 May, 6 p.m.

Society of Engineers

LONDON
"New Jet Propulsion for Boats," by R. H. Bound. At the Engineering, Marine, Welding and Nuclear Energy Exhibition, Olympia, W14. Mon., 1 May, 5.30 p.m.

Society of Instrument Technology

LIVERPOOL
Annual General Meeting and Film Evening. Liverpool Section. Industrial Development Centre, Manchester and North Wales Electricity Board, Liverpool. Thurs., 11 May, 7 p.m.

Women's Engineering Society

LONDON
"Visit to Russia," by Miss R. Winslade and Miss L. Souter. London Branch. Hope House, 45 Great Peter Street, SW1. Wed., 10 May, 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London, SW7. (KENsington 3744)
Institution of Civil Engineers, Great George Street, London, SW1 (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661)
Institution of Engineering Inspection, 616 Grand Buildings, Trafalgar Square, London, WC2. (WHItehall 0818)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

Flexibility for Communications Centre

A new telecommunications centre has been opened in London. Despite the high content of electrical and mechanical services, adaptability of lay-out has been the key to the design.

FLEET BUILDING has been designed to meet the requirements of the General Post Office and house both operational equipment and office staff. It is London's new telecommunications centre. In it is the automatic Telex switching exchange which gives access to the whole of the United Kingdom, the continent and other places abroad; and it will eventually accommodate the Fleet Street telephone exchange and a further exchange if required. The site is roughly square, with sides of 230 ft by 250 ft.

The building consists of 15 floors, the lower six floors being 14 ft 9 in floor to floor and designed to take heavy loading for Post Office equipment; the upper nine floors are 10 ft floor to floor, for lighter office loading; the three lower floors are mainly in basement accommodation.

EQUIPMENT DICTATES MODULE

The plan of the building has been dictated by operational requirements, and a module dimension of 11 ft 5¼ in was chosen to agree with Post Office apparatus lay-out. This module runs in both directions and, within each module dimension, two window bays have been provided; this means that standardizing of dimensions has been possible throughout the building. The irregular dimensions of the northern boundary have been taken up with three staircases, which vary in width.

The superstructure is of reinforced concrete construction throughout, with solid floors in operational areas and hollow pot tile construction for office floors and roofs. Generally, the columns are carried directly on the retaining walls and the foundation slab next to earth. The column spacing externally is 5 ft 8⅝ in throughout to suit the module construction. Where the construction is hollow tile, a flush soffite appears between the internal spine beam and external columns; in operational areas cross beams span at 5 ft 8⅝ in centres.

The building is founded on firm clay at a maximum depth below pavement level in the south-west corner of 50 ft. The walls of the basement are of semi-mass concrete construction with a maximum thickness of 9 ft. Most of the retaining walls were constructed by the "trench and dumpling" method and only a little water was encountered during the excavations. The specified minimum concrete cube strength at 28 days was 4,000 lb per sq. in for all structural members.

Generally, the columns and beams have been left fair-face and not plastered, and throughout the job column and pier sizes were standardized. Bored piles were used on the northern excavations where constructional difficulty was experienced with adjoining buildings.

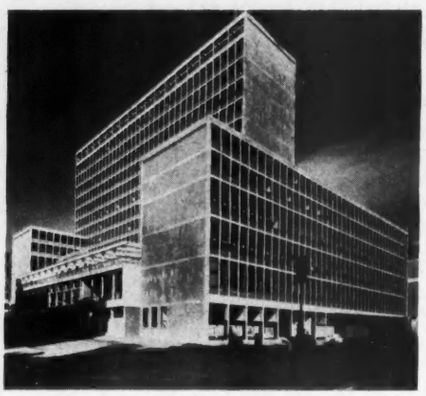
The external stonework is Portland stone with the exception of the end flank walls, which are in-filled with Derbydene stone. Window frames are in teak with the exception of those of the dining room, which are of aluminium.

The windows throughout the job have been standardized. Windows to offices and those operational areas which require quietness, have been double glazed; Venetian blinds will operate between the two sheets of glass. Because of the modular lay-out of the building, it was possible to standardize partition lay-out and these are fully demountable in dry construction and are faced with an easy cleaning plastic finish. The partitions, in one-bay lengths, can be taken down and re-erected by two men in approximately one hour. Electrical services have been accommodated on solid walls to facilitate the movement of demountable partitions.

Continuous ceiling trunking has been provided in the office areas, with lighting units which can be re-positioned to suit the lay-out. In other words, the offices have been designed to give flexibility to meet changing needs of the occupying department at the minimum expense.

The drainage to the basement garage has been taken through the petrol interceptor to the sub-basement floor level from where it is then pumped into the gravity surface water system.

The drainage in the kitchen area has been laid within a void of 1 ft 3 in between the permanent floor slab and the under-side of the false floor; this void is watertight to give protection to the Post Office apparatus immediately below.



Fleet Building.

Drinking water and fire hose supply was needed at each floor level and also a supply from storage to serve the sanitary fittings. The water storage is at 5th and 13th floor levels. The mains pressure (60 lb per sq. in) is insufficient to provide a service to the 13th floor tanks and a boost unit with a compressed air vessel is used to maintain adequate pressure in the rising mains, serving the 13th floor tanks and drinking water above 5th floor level; in a separate riser it also serves fire hose reels at all floor levels.

Tracking for permanent window cleaning gear has been laid on all roofs. The window cleaning trolleys at the top of the building have been designed to operate at a high level so that the roof space under can be used by the staff. Glass panels form the balustrading to allow those who are seated there to obtain an unobstructed view and also get protection from the wind.

In view of the size of the building, adequate yard accommodation for servicing the building had to be given at street level, and garage space allowed for off-street parking.

It was necessary to give early occupation of the basement areas to enable Post Office equipment contractors to install the Telex automatic equipment, which came into operation in December, 1960. This meant that the basement had to have temporary overhead protection against the weather and also adequate heating arrangements while the remainder of the building proceeded.

MECHANICAL SERVICES

Heating.—The boiler house in the sub-basement is approximately 30 ft in height. It has four Economic boilers which are fired by modulating oil burners with sequence control operating on 900 sec. The boilers provide high pressure hot water at 290° F and feed six calorifiers for central heating and three for domestic hot water. The building is divided into six zones for heating purposes, each zone being on one calorifier with thermostatic control working in conjunction with exterior pilots registering the outside atmosphere. The domestic hot water calorifiers are fed from the main boilers during winter months and from a small oil-fired boiler during the summer, again under thermostatic control. An out-flow heater is fitted in each oil tank connected to the high temperature hot water system, one tank being fitted additionally with an electric thermostat for starting-up periods.

Heating is by low pressure hot water radiators throughout and the surface area of pipes, convectors and radiators totals 64,000 sq. ft. Each main boiler (one being a stand-by) is capable of producing 4 million Btu and the estimated total load is 11 million Btu, of which 750,000 Btu relate to hot water service load.

Ventilation.—In operational areas (the lower five floors) forced ventilation is through filters which, in the case of the basement accommodation, are electrostatic in operation. In addition, the basement accommodation is served by air-cooling plant during summer. The basement garage has a separate extract ventilation system. The extract ventilation of the conference rooms and the assembly hall is sufficiently effective to withdraw tobacco smoke fumes and a small inlet ventilation plant also serves the assembly hall. Extract ventilation for the kitchen is to roof level. The total volume of air handled by the ventilating plants is 120,000 cu. ft per minute.

Electrical.—The supply for lighting and power is brought into the building at high tension through two transformer and two main switch rooms. Distribution to lighting circuits and power points is by means of rising bus-bars and underfloor ducting. Most of the lighting is fluorescent, the fittings for which are attached to continuous lines of ducting as previously described.

An automatic emergency lighting installation exists for all apparatus rooms, the assembly hall and exits. All corridors, staircases and certain essential plant can be supplied from diesel generators in an emergency. The total connected electrical load is 1,500 kW.

Canteen.—The kitchen is fully equipped with gas cooking and ancillary electrical equipment for the provision of 11,000 main meals daily; and the dining room is designed to seat 560 persons at a time. Eventually it is intended that the canteen shall be operating 24 hours a day throughout the year.

Lifts.—There are six high-speed passenger lifts in two groups of three, each with special automatic group control for rapid dispersal of the staff to and from the fifteen floors. These lifts function at the rate of 500 ft per minute. The top floor of the tower block is not served by lifts, so that the lift over-run can be accommodated in the roof structure. There is also a goods lift to serve the kitchen, and registries on the floors above, leading direct to the yard.

Fire Prevention.—The usual hand-operated first aid fire fighting equipment has been installed on every floor, and a dry riser and hose reels are installed adjacent to the two main staircases. An automatic sprinkler system has been fitted for the basement garage. Control of two of the passenger lifts mentioned above can be varied specifically for fire fighting operations and the lift lobby serves as a break between the escape stairs and the main accommodation. Post Office engineers have installed a hand-operated electric fire alarm system.

The design and supervision of construction has been the responsibility of the Ministry of Works; for the structure they were associated with W. V. Zinn, consulting engineer, of London; and for the electrical and mechanical engineering services with the Post Office engineering department. The main contractor was Tersons Limited, London, N3.

Lightweight Steel Flooring

A Dexion product originally designed for use in association with their slotted angle equipment has proved so successful that the firm say that it is rapidly becoming accepted as a structural material in its own right. It is Dexion open steel plank designated DOSP for short.

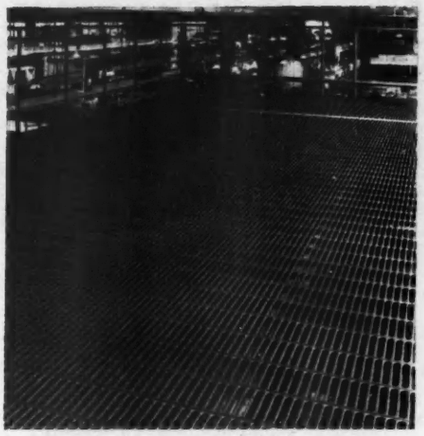
When slotted angle was launched in 1947 as a general constructional material for industry, its versatility in the field of storage was quickly demonstrated. Installations became more and more ambitious, and it was soon clear that a multi-tier unit would have to be provided. It was largely as a result of the research that followed that DOSP came into being, and it was immediately successful as a flooring material for raised storage platforms, walkways, stairways and access equipment—all incorporating the slotted angle which open steel plank was designed to complement. Works engineers quickly found it an ideal material for many flooring jobs, and when used in association with steel joists, it has provided large raised areas of great strength. In many jobs the DOSP has been the primary material, with slotted angle in a secondary role as a rail surround or a similar minor function.

A recent and novel example of this was a fire escape walkway at the Avonmouth factory of R. Silcock and Sons Limited, manufacturers of animal feeding stuffs. Steel valley beams in the factory roof were used as supports for the installation, which serves personnel working on the four upper floors of the plant.

Another example of DOSP for walkways is to be seen at the Kenton, Middlesex, premises of British Building Supplies Limited, where four access aisles 8 ft 6 in above floor level are supported on scaffolding tubing to serve a second tier storage installation.

Rolled steel joists were also used to support an ambitious raised storage area of DOSP flooring at the Park Royal Road service department of Ultra Radio and Television Limited.

DOSP is manufactured in standard sections 9 in wide and 4 ft 6 in or 6 ft long, making for simple designs and speedy erection. It is a single pressing of 16 gauge mild steel, with 1½ in side flanges punched at a 1½ in module. A dimple pattern gives a non-slip surface in all directions. A single plank supported at a maximum interval of 4 ft 6 in carries a distributed load of 360 lb with a safety factor of 2. DOSP is etch primed for rust protection and stove enamelled battleship grey. Hot dipped galvanized finish is also available.



For specialized uses, particularly where lightness and non-sparking qualities are desirable, an light alloy version—open aluminium plank—has been developed. This is claimed to be the lightest metal flooring on the market.

Dexion Limited, 67 Maygrove Road, London, NW6.

Air Conditioning and Floor Heating for Swimming Pool

The illustrations show a new indoor swimming pool built by the City of Manchester at Wythenshawe to serve the surrounding housing and manufacturing estates. Built mainly of reinforced concrete, it was officially opened in March, three months ahead of schedule.

The main entrance leads into a foyer from which two staircases give access to the first floor coffee lounge. Beyond the foyer is a restaurant which is separated from the bath hall by a glazed screen. To allow the restaurant to be used as an extension to the pool area for special events, the screen can be lowered into the basement. The pool, which is 110 ft by 48 ft wide, varies in depth from 3 ft 3 in to 12 ft, and underwater windows in the bath walls provide lighting and observation. The diving stage, with fixed 3 metre and 5 metre boards and a 3 metre spring board, comprises two inclined concrete columns piercing two concrete platforms cantilevered in all directions. Flanking the pool on two sides is tiered tip-up permanent seating to accommodate 828 spectators. Below the terracing is the dressing accommodation, consisting of 136 changing cubicles and Hi-Gard-All clothing storage for 564 bathers. The basement surrounding the pool contains the filtration, chlorination, heating and electrical equipment.

Foundations for the pool floor and basement are of mass concrete but the superstructure of the building is founded on concrete piles with ground beams spanning between them. The pool is contained within a 12 in thick waterproof reinforced concrete floor and 9 in thick side walls lined with white faience glazed tiling.

The main roof of the building consists of *in situ* concrete arch members, 14 in by 12 in in section, spanning 82 ft 6 in and spaced at 13 ft 4 in centres, springing from cantilever L frames. Trough-shaped precast concrete units span between the arches and these are finished on the underside with sprayed asbestos and on the top with a bituminous vapour barrier, cork insulation and a bituminous felt roofing.

Heating and ventilation is by electricity and consists of embedded floor heating supplemented by a hot air ventilation system calculated to maintain even temperatures and to eliminate condensation. Water for the pool and showers is also heated by electricity, the temperature of the pool being maintained at 74° F.

The filtration equipment consists of eight filters and the whole of the water will be pumped through the filters once every 2½ hours.

The pool has been built to the requirements of the City Architect of Manchester, Mr. Leonard C. Howitt, F.R.I.B.A.

The siting, construction and equipping of a public swimming pool and its ancillary buildings have to comply with the requirements of local by-laws which are usually in accordance with the Ministry of Housing and Local Government model by-laws, series VIIIa. Dimensions and diving board arrangements are advisably made to comply with the championship requirements of the Amateur Swimming Association.

Beyond the foyer is a restaurant.

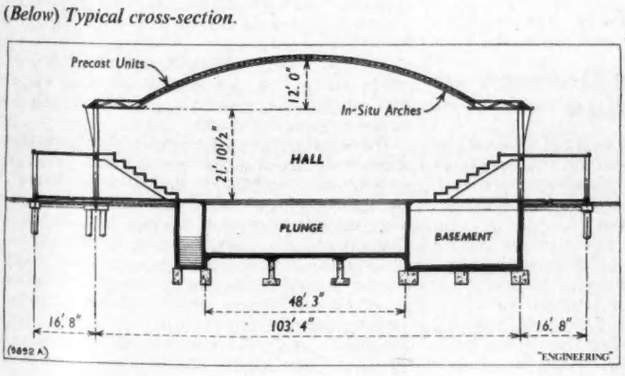
A small booklet *Design and Construction of Open Air Swimming Pools* has been issued by the Cement and Concrete Association recently. It is available, on request, from the association at 52 Grosvenor Gardens, London, SW1.

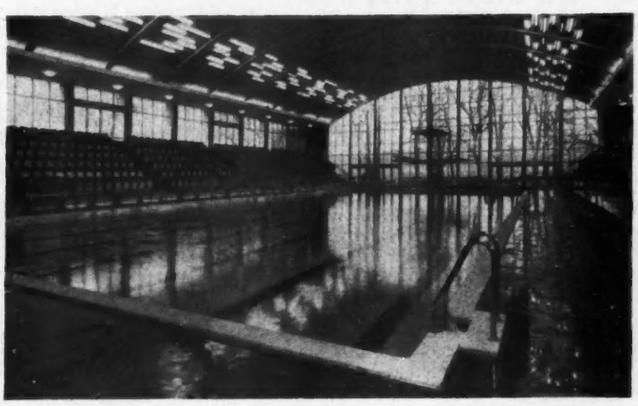
Consulting Engineers: Truscon Limited, 53 Lower Marsh, London, SE1.

Contractors: Simon-Carves Limited, Cheadle Heath, Stockport.

(*Right*) *The pool is 110 ft by 48 ft wide.*

(*Below*) *Typical cross-section.*



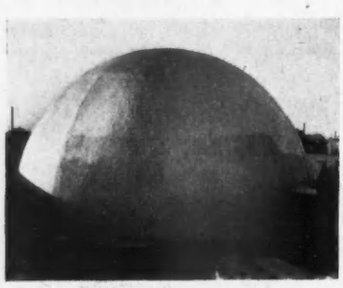


Timber Dome Formwork

The timber dome shown in the two illustrations was recently completed for Darchem Engineering Limited at Stillington. It is a complete hemisphere and is required for the erection of instulation by Darchem within nuclear reactor shields being built by Whessoe Limited.

The outer dome is 75 ft in diameter and is made up of two layers of ¾ in tongue and groove boarding laid on 16 laminated timber ribs,

Inside the nearly completed dome.



The completed outer structure.

each of 9½ in by 6 in cross-section. "Casco" casein glue was used for laminating the ribs and the boarding was fixed down with screws. The inner dome is made up of a timber framework lined with plywood.

The whole structure stands on a concrete base. Synthaprufe and Ritolastic were used to make the outer skin waterproof. The estimated cost of the outerdome is a little over 16*s* per sq. ft.

The design was prepared by Hume and Tottenham to the requirements of the Timber Development Association. The builders were Tysons (Contractors), who completed the main structure in about three months.

Hume and Tottenham, 1 Hertford Place, London, W1.

Tysons (Contractors) Limited, Dryden Street, Liverpool 5.

Safeguard against Static Electricity

A flooring material that helps eliminate explosions and other dangerous conditions due to the build up of static electricity has been developed by the Phoenix Rubber Company. Announcing Phengard, as they call the new material, the company recall that many lives have been lost in the past as a result of static electricity that was not properly earthed sparking off combustible matter such as ether in hospital theatres, or the constituents of high explosives.

Phengard is made by compounding minute particles of carbon black, which will conduct the charge, to a 2 in strip of brass foil laid under the floor covering. The brass foil in turn takes the static electricity harmlessly to earth. It is made in two classes: one specially for hospitals and the other for more general commercial use. The hospital grade is sufficiently conductive to discharge static electricity to earth but resistant enough to act as an insulator against low tension currents. The commercial grade gets rid of any static charge by rapid dissipation in conditions where protection against low tension shock is not necessary.

At present Phengard can only be supplied in black, but efforts are being made to see whether other pigments can be introduced to give a variation in the colour.

Phoenix Rubber Company Limited, Slough, Buckinghamshire.

Austrian Experience with Steelworks Slag Cement

The composition of steelworks slag is similar to that of volcanic lava. It is free of organic material can be solidified by either rapid or slow cooling in either a crystalline or amorphous form. By appropriate treatment, the slag may have a density of 1,800 kg per cu. m (140 lb per cu. ft) or as little as 50 kg per cu. m (38 lb per cu. ft).

An Austrian steelworks is currently turning 50 per cent of its slag into slag pumice. To obtain adequate porosity, steam is injected into the slag from below and good strength is obtained by slow cooling. The crushing machines used have been selected for the good grain form that they produce. The pores of the slag pumice

20 storey building in Linz where lightweight slag cements were employed.

are round and closed and the material has good insulation properties.

Use is now being made in Austria of a high strength concrete which consists entirely of slag products and it has been found particularly well suited for the construction of multi-storey buildings. The concrete is said to consist of 45 per cent slag pumice and of fine slag aggregates and slag cement. The concrete is consolidated by immersion vibrators. In the 20 storey building shown in the illustration, built in the town of Linz, the first eight storeys were constructed of these materials. (*European Technical Digest No. 4177*).

Voest Steel Works, Linz, Austria.

Indus Survey to Correct Drainage Damage

A major contract has been awarded to Hunting Technical Services for the survey and design of control works that improve the drainage and reduce the salinity of 10 million acres in the Indus Basin in West Pakistan.

The need for the work is due to the waterlogged character of much of the area and the high salt content of the ground. These conditions appear to have been brought about by earlier works in the area that included barrages across the river. These barrages were built around 1932 and the initial results were very good, millions of acres of land becoming fertile for the first time and many crops were successfully raised.

Since then the water table level has steadily risen, leading to two effects. One is that in some areas the ground has become water logged while in others there has been excessve evaporation of surface water, leaving behind a salt ridden desert.

The contracts now to be carried out (they follow a smaller one let to the same company in 1959 for the first phase of the work) are for the investigation of soil permeability, salinity, water table levels and a survey of agricultural possibilities in the area. Following the completion of the surveys and the trial of different drainage systems, the company will prepare documents for a pilot scheme covering 5,000 acres.

Associated with Hunting in the work are Sir Murdoch MacDonald, the consulting engineers of London, and Drilling and Prospecting International (associates of Turriff Construction Corporation) who will put down the trial wells.

Hunting Technical Services Limited, 6 Elstree Way, Boreham Wood, Hertfordshire.

Defeating Pipeline Corrosion

A plastic-coated steel pipeline, 4 in in diameter and having a capacity of 126,000 gallons a day, has recently been completed in the Eastern United States through a stretch of corrosive ground that is, in some parts, water-logged.

Over 42,000 ft of the pipe, Republic Steel Corporation's X-Tru-Coat, was laid between the United Refining Company's tank farm and refinery in Pennsylvania. It was installed in less than four weeks by an eight-man gang with a side-boom tractor and a back hoe.

The pipe is shipped with either end of the coating "cut back" about 4 in to allow welding of the bare steel to the exposed end of the next

Laying the plastic-coated steel pipeline.

length. After welding, the exposed joints were wrapped with a pressure-sensitive plastic tape to keep out moisture. Republic Steel supplies a yellow polyethylene tape with a suitable primer for joint protection.

The pipe "skin" is bright yellow in colour to reflect heat in storage. This feature also makes the installed lines easier for workmen to spot on future projects in the area.

The coating is of high-density polyethylene and is extruded directly over the steel pipe and an adhesive compound is used to bond the coating and the pipe so preventing underfilm migration. Unlike other pipe coatings, says Republic Steel, the plastic skin does not become brittle and crack in winter or become soft and sticky in the summer. Moreover, the pipe can be stored in any climate without deterioration for long periods of time.

Republic Steel Corporation, 405 Lexington Avenue, New York 17, USA.

Human Element

Cutting Down on Fractures of the Foot

A THIRD of all the foot injuries over a two year period recorded by the medical officer of the Rolls-Royce aero-engine division involved fractures. Every one of these injuries the medical officer regards as " mitigable "—capable of having been avoided altogether, or the damage much reduced, if safety footwear had been worn.

Each employee suffering from a mitigable foot injury was away from work, on average, for just over a week. Other, though much smaller, interferences with production and efficient working were caused by interruptions while injured men were helped to the surgery by their colleages, as was invariably the case, and by subsequent time taken up with dressings and re-dressings.

Writing in the medical journal *The Practitioner*, the Rolls-Royce divisional doctor points out unsuitable footwear as the most serious single factor in injuries to the foot. The major cause of such injuries is the dropping of objects on the toes. Things dropped on the foot include grinding wheels, castings, boxes, steel plates, steel and iron blocks, dies, glass plates and spanners. One of the most commonly dropped objects is the casting.

Safety footwear has for many years been encouraged in the aero-engine industry and is used by many of the employees, some of whom take advantage of the weekly payments schemes operated by managements. But, as the accident toll shows, the number of workers wearing safety shoes or boots is far short of what it should be. And being once bitten does not seem to make people shy of going without proper foot protection. All too common is the attitude that if it has happened once it is not going to happen again.

There is now a vigorous drive to encourage the wearing of safety footwear and a useful aid in the campaign is a lighter shoe. This lighter style will, it is hoped, take the force from the complaint that safety shoes are a good idea but too heavy.

Staff Still Drifting away from Railways

Over the last ten years the Central Transport Consultative Committee for Great Britain has investigated and agreed to the closing down of 3,000 route miles on British Railways' branch and local lines and to the closure of more than 700 stations.

The committee's annual report criticises the manner of presentation of the closure proposals of some regions in 1960, leading to a situation in which neither the local committee nor the objectors were able properly to understand the issues. A section of the public still misunderstand the purposes of the committee and seem to believe that its value should be judged by the degree to which it thwarts the intentions of the British Transport Commission. The existence of the committee is itself a safeguard against ill-considered proposals. One result of its work has been that almost 60 per cent of proposals had gone through without public opposition.

Staff shortages in the Midlands are holding back the rail services in the area where perhaps it will hurt most in the long run, in causing what the annual report calls grave delays to freight. Long service drivers and signalmen have given up and gone to other jobs that are lighter in nature and better paid. The last round of pay rises seem not to have produced a solution and the prospect is held out of passenger services being cut in order to keep the freight trains on the move. Some lines and stations are only now being kept open with difficulty due to the staff position.

Line closures recommended in 1960 affected 33 branches, 105 route miles of passenger service, 67 route miles of freight service and 75 miles of freight and passenger service. The estimated minimum annual saving is slightly over £300,000.

Public complaints are still in the main concerned with unpunctuality. Although 71 per cent of all trains in the railway system arrived on time or within 5 minutes of time the percentage of express trains arriving more than 20 minutes late in some regions was still considerable. Staff shortages and modernisation works were among the causes.

Vauxhall Still Reducing Accidents

The Vauxhall Motor Company, of Luton, Bedfordshire, who are long standing leaders in industrial safety, reduced their injury rate, and the number of lost-time injuries last year, despite an increase in the number of hours worked.

One of the reasons for Vauxhall's success is the liveliness of their presentation throughout the whole safety effort. Their *Safety Report* for 1960 has turned the whole thing into steeplechase terms, with a front page illustration of the course, each hedge being the hours worked in a particular year, with the accident frequency rate, declining every year, marked against it. Results boards, race scenes, a departmental handicap chase and other opportunities for humour get a serious subject over with the maximum grip on attention.

The falling accident rate and the increased number of hours worked are shown in this table:

Hours Worked	
1959	47,280,608
1960	48,343,957
2 per cent increase	
Injury Rate (Number of injuries each 100,000 hours)	
1959	0·55
1960	0·48
12½ per cent decrease	
Lost Time Injuries	
1959	261
1960	232
12½ per cent decrease	

Of Vauxhall's 32 departments, 20 improved their accident records and five of them finished the year with a completely clear record in 4½ million working hours, qualifying for the 1960 Safety Awards of Merit awarded by the company.

Back in 1945 the frequency rate was 3·3; by 1948 it was down to 2·01 and by 1954 to 0·87.

Among the particular points where an improvement is looked for is the nightshift. Accidents are still disproportionately high there and the safety report says the situation would be relieved by increased vigilance and emphasis by the supervision on the need for extra concentration and care in the small hours.

The proportion of accidents among the under 25's has risen from 8 per cent in 1959 to 10 per cent last year. The 25 to 45 age group have let theirs go up from 62 to 64 per cent. The over 45's have reduced their injuries from 30 per cent in 1959 to 26 per cent last year.

Echoing the Rolls-Royce aero-engine division experience, reported elsewhere on this page, Vauxhall lament " there is still need for wider use of safety footwear to save the toes, only 10,733 pairs were sold in 1960."

Engineering Education and Industry

The numerous experiments in engineering education going on in Europe, many of them involving cooperation between educational bodies and industrial organisations, were among the subjects discussed at the recent OEEC conference on engineering education and industry held at Baden-Baden.

Eighty industrialists and representatives of educational authorities and ministries attended the meetings. The Fédération Européenne d'Associations Nationales d'Ingénieurs (FEANI) and the Conference of Engineering Societies of Western Europe and the United States (EUSEC) were represented.

The conference gave much of its attention to considering the development of cooperation between industry and the educationists. Detailed discussion was given to means by which industry and education could work more closely together in defining policies for developing engineering education in relation to the needs of individual states and their resources; in preparing educational programmes for technologists, technicians and craftsmen, and in providing staff, material and money for education.

The host institution to the conference, organised by the OEEC Office for Scientific and Technical Personnel, was the Gesprachskreis Wissenschaft und Wirtschaft. The GWW is a centre for the discussion of problems of common interest to science and industry, sponsored by the Federation of German Industries and the Donors' Association for German Science.

Reviving Rootes' Sales Ends Dismissals Plan

The Rootes Group announcement in Coventry that it is not going on with the plan for the dismissal of 720 workers signals the effective end of the motor industry's recession.

Improving sales in the home market and in the United States have materially changed the position of Rootes and others. The plan for the sackings was first made known back in February and at once ran into opposition from shop stewards based on expectations of the approaching increase in demand.

Only a month ago the dismissals were again put back for six weeks, with the qualification that if short time working was still necessary there would be no further delay in giving notice. While sales have been picking up and the plan has been held over there has also been some movement of workers away from the factory, producing the latest situation in which the management are able to announce that after reviewing the position there is no need for further labour dismissals.

At the same time in New York the Rootes organisation was describing the New York Motor Show as " a terrific springboard for sales."

The labour position is expected to be reviewed later in the year, possibly in the early summer when it is more likely that the sales outlook for the rest of the year can be accurately surveyed.

Lord Rochdale's Inquiry into UK Port Efficiency

The Minister of Transport, Mr. Ernest Marples, is completing the membership of the committee which is to look into the adequacy of the United Kingdom docks and harbours and whether improvements can be made in work methods. It is to be hoped that the committee will report with a speed fitting the urgency of the problems involved.

If there is to be the expansion of exports in 1961 looked for by the Chancellor of the Exchequer, Mr. Selwyn Lloyd, then unless improvements are brought about, the greater outward flow will be seriously hampered by the decline in the pace of turning ships round. The use of great ports like London and Liverpool is, of course, a source of earnings in itself, and it must be a cause for concern to see advances being made on the Continent that are not matched in Britain.

The docks and harbour committee is to be headed by Lord Rochdale, the Cotton Board chairman. Mr. Marples has described the committee as being dispassionate, without a representative of the employers or the unions. It will be able to take evidence.

Institute of Management Appoints a Director

John Marsh, since 1950 director of the Industrial Welfare Society, is to become director of the British Institute of Management from October this year.

Before joining the Industrial Welfare Society Mr. Marsh had, from 1947, been director of the Institute of Personnel Management. His first management experience of all dates from the time when, at the age of 18, he was running a bus company in China.

Delivering 150 lectures a year for the past eight years, Mr. Marsh has appeared in person before very large numbers of those whose activities take them into management institutes in Britain and overseas, and to the lecture halls of universities and technical colleges.

It was from Mr. Marsh that the Duke of Edinburgh received the idea of a Commonwealth Study Conference on the problems of industrial communities, and he continued his association with the scheme as its honorary organizer.

As an apprentice supervisor with the Austin Motor Company, up to 1939, and later on the personnel side of the British Overseas Airways Corporation, Mr. Marsh has worked for private and nationalised industry.

The Choice of Cutting Tool Materials

Today, cutting tool materials are becoming more specialised as engineering imposes greater demands on them. A knowledge of their different properties has become invaluable to the engineer.

By J. Cherry, M.I.P.E., A.M.I.Mech.E.
College of Aeronautics, Cranfield

THE frequent introduction of new engineering materials, such as titanium and Nimonics, and the progressive development of higher strength alloys to current tensile strengths of the order of 120 tons per sq. in, together with the eternal quest for higher productivity, impose insistent demands on tool manufacturers for improved tool materials and tool designs to meet the needs of industry. A continuous search persists for materials which will sustain higher cutting temperatures with minimum sacrifice of hardness, strength, toughness and resistance to abrasion.

It is the provision of the combination of hardness and toughness which creates the difficulty of producing a tool material to satisfy all requirements—hence the wide range of tool materials with different characteristics from which to select the appropriate tool material for a specific job. Examination of the machining problem as a whole is necessary in order to establish the requirements of the process before a tool can be selected.

In choosing a tool, consideration has to be given to the following factors:—

(1) Nature of the process (whether shock loading is present, etc.),

(2) Work material (cutting loads on tool and cutting temperature, etc.),

(3) Speed range and power available (whether adequate for sintered carbides or oxide), and

(4) Condition of machine (vibrations, etc.).

Probably the greatest advance in cutting tool materials has been in the development of the sintered oxides and a stage has now been reached when few machines are capable of fully exploiting these materials. Higher speeds, more power and greater rigidity are necessary before their full effect can be felt. Advances have been made in most of the different categories of tool materials.

The principal tool materials in use in industry today are high speed steels, cast non-ferrous metals, sintered carbides, sintered oxides and diamond.

One of the major properties distinguishing tool materials is the hardness which each retains at the temperature generated by cutting. Hardness is plotted against temperature for a range of materials in Fig. 1. Toughness is another major property, but it is inversely proportional to hardness and thus the materials with a good hardness property generally have a poor toughness property. It is for this reason that the overall situation has to be examined before the most suitable tool material can be specified.

High Speed Steels.—The most widely used high speed steel has the composition: 18W-4Cr-1V. Increase of the percentage of vanadium improves the hot hardness property and the resistance to abrasion, while toughness is reduced as a consequence. The addition of cobalt also increases hot hardness and resistance to abrasion.

Thus, by varying the proportions of the major elements, physical properties can be modified to improve hardness or toughness as desired. The compositions of some of the more common high speed steels are shown in Table I.

To combat the difficulties encountered in machining tough materials like Nimonics, development has recently taken place of a high carbon, high vanadium, high speed steel whose composition is 1·25/1·5C-12·5/13·5W-4·0/5·0V. While this material has a reduced tungsten content, its hot hardness exceeds that of 18W-4Cr-1V high speed steel. It is highly resistant to abrasion and although its toughness

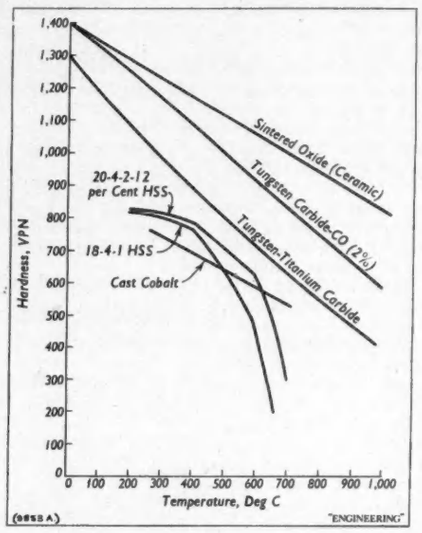


Fig. 1 Hardness retained at cutting temperatures is a major property of cutting tool materials.

is reduced it is capable of intermittent cutting.

The addition of cobalt to this class of material, making the composition 1·5C-12·5W-5·0V-5·0Cr, increases further its hot hardness and resistance to abrasion.

Improvements in the structure of high speed steel by controlled heat treatment in which all austenite is converted to martensite has resulted in increased cutter performance. Both hardness and toughness have been improved.

A comparable approach in which the austenite formed by grinding is removed to give improved cutter performance, is carried out in the "Golden Arrow" and "Blue Arrow" treatments. In addition to the removal of austenite from the surface, lubrication properties are imparted.

Further developments have taken place to improve the properties of high speed steel by the deposition of titanium/tungsten carbide on the wearing surfaces of the tools. Results on turning tools and drills have shown promise and the technique is successfully applied to taps. The process is attractive where both toughness and resistance to abrasion are required.

Tool designers are faced with the challenge of providing suitable designs which will reduce impact loading to extend the use of these materials. Improved machine tool and cutting tool designs should result from this. Even now, tool manufacturers are rising to the challenge

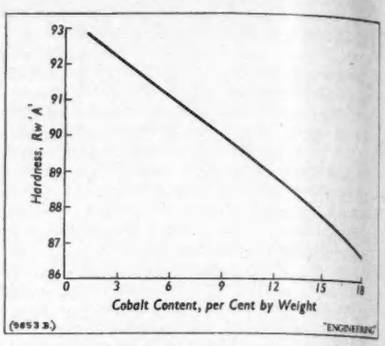


Fig. 2 The effect of cobalt content on tungsten carbide tools.

and the development of the sintered titanium carbides is evidence of this.

Experimental work is also being conducted into materials of even greater hardness than the sintered oxides, among which are silicon carbide (2,500 Knoop) and boron carbide (2,800 Knoop), and these, of course, will place even greater demands on machine tool design.

A further surface treatment which imparts a sulphur and nitrogen rich layer to the surface of the tools reduces friction and increases tool life. The hardness of the surface is slightly increased, but the major benefit is reduction of friction.

A most notable development is the manufacture of high speed steel cutters by casting. The material used is based on high carbon, high chromium alloy and gives a performance comparable with 18W-4Cr-1V high speed steel. This technique could effect considerable economies.

Cast Non-Ferrous Metals.—The cast non-ferrous materials such as Stellite, have a high cobalt (approximately 60 per cent), high chromium base. While being softer than high speed steel at room temperature, they retain their hardness for a longer period with increase in temperature as can be seen from Fig. 1.

This feature enables them to work on tougher materials and to take heavier cuts than high speed steel tools. Being a cast alloy, however, they have a low resistance to shock and good support must be afforded to prevent fracture.

Sintered Carbides.—The sintered carbides are much harder than both high speed steel and cast non-ferrous tools. They also retain their hardness with increase in temperature to a greater extent, as can also be seen from Fig. 1. The original material in this group was tungsten carbide which used a small percentage of cobalt as a binder. This material has extremely high hardness, but this unfortunately is accompanied

TABLE I:—*High Speed Steels*

High speed steel	Percentage								Usual working hardness, Rockwell C
	Carbon	Manganese	Silicon	Tungsten	Chromium	Vanadium	Molybdenum	Cobalt	
1. Tungsten-cobalt	0·65/0·90	0·15/0·35	0·15/0·50	18·00/23·00	3·50/4·75	1·00/3·00	1·25 max.	9·00/15·00	62—66
2. Tungsten-cobalt	0·65/0·90	0·15/0·35	0·15/0·50	17·00/21·00	3·50/4·75	1·00/2·50	1·25 max.	5·00/9·00	62—66
3. Tungsten-cobalt	0·65/0·80	0·15/0·35	0·15/0·50	17·00/20·00	3·50/4·75	0·75/1·50	1·00 max.	2·00/5·00	62—66
4. Tungsten-cobalt	0·65/0·85	0·15/0·35	0·15/0·50	12·00/15·00	3·50/4·75	1·00/2·25	0·75 max.	3·00/8·00	63—67
5. 18-4-4, 18-4-3	0·90/1·30	0·15/0·35	0·15/0·50	17·00/19·00	3·50/4·75	2·50/4·25	1·00 max.	—	62—66
6. 18-4-2	0·75/0·90	0·15/0·35	17·00/0·50	3·50/19·00	1·50/44·75	1·00/2·50	? max.	—	57—66
7. 18-4-1	0·55/0·80	0·15/0·35	0·15/0·75	16·00/21·00	3·50/4·75	0·50/1·50	0·75 max.	—	

by low resistance to shock. Additional grades have been introduced, therefore, in which the percentage of cobalt has been increased in order to improve the shock resisting properties. The effect of cobalt content is shown in Fig. 2.

While the straight tungsten carbide-cobalt material showed extreme resistance to abrasion when machining cast iron, cratering rapidly developed when steel was machined. To counteract this disadvantage, small amounts of titanium or tantalum or both, were added. Thus a second main class, particularly suitable for machining steel, was introduced. Also, within this classification, a number of grades have been introduced to give varying degrees of hardness and toughness. The properties of representative sintered carbides are shown in Table II, and in Fig. 3.

Because of the greater hardness of titanium carbide, 2,200 Bhn compared with that of tungsten carbide, 1,500 Bhn, a high titanium carbide containing in the order of 60 per cent titanium has been developed with greater hot hardness than the tungsten-titanium carbides, although as a consequence it has reduced toughness. This material reduces the gap between the sintered carbides and the sintered oxides.

Sintered Oxides (Ceramics).—Much development work in recent years has gone into the manufacture of sintered oxides, principally aluminium oxide. This material is harder than tungsten carbide and it retains this hardness with increase in temperature as shown in Fig. 1. It is more brittle than tungsten carbide and special precautions are necessary fracture.

Sintered oxides will sustain speeds in the order of twice the speeds sustained by tungsten carbide for the same tool life. Hence to derive full advantage from the oxides, machines will require higher spindle speeds accompanied by greater power. Also, because of the susceptibility to fracture of the sintered oxides, vibration must be kept to a minimum. The high hardness of the sintered oxide also enables work pieces as hard as 55 Rc to be machined instead of grinding.

Diamond.—Diamond is by far the hardest cutting material, having a hardness of 7,000 Bhn. As a consequence, it has low shear strength and must be well supported to avoid fracture. Its low coefficient of friction and high heat conductivity tend to keep the cutting temperature down. This is of importance for fine finishing operations, on which diamonds are most effective, particularly on soft materials such as plastics, aluminium and copper. In addition, their extreme hardness permits the form dressing of grinding wheels to a high degree of accuracy.

TABLE II:—*Representative Sintered Carbides*

	Composition				Abrasion resistance	Impact resistance	Crater resistance	Rockwell Hardness, "A" Scale
	WC	Co	TaC	TiC				
Grade for cast iron	97	3	—	—	High	Low	Low	92·1
	94	6	—	—	Medium	Medium	Low	91·0
Grade for steel	85	10	1	4	Low−	High+	Medium	90·5
	82	10	—	8	Low	High	High	90·5
	76	8	4	12	Low+	High−	High	92·0

Applications

Fig. 4 is given as a general guide to the range of work materials, with approximate cutting speeds, covered by the main classifications of tool materials. In the case of sintered aluminium oxides, aluminium alloys should be avoided since aluminium tends to weld to this material.

The information given applies only to continuous cutting where impact loading is absent. Diamond and sintered oxide are at present unsuitable for impact loading and even sintered carbides require special consideration to counteract intermittent cutting

In the future. the development of the sintered oxides presents a challenge to machine tool manufacturers to provide machines free from vibrations and capable of the high speeds at which these materials can operate.

Next week, Mr. Cherry will conclude his survey with an article on tool design and utilization.

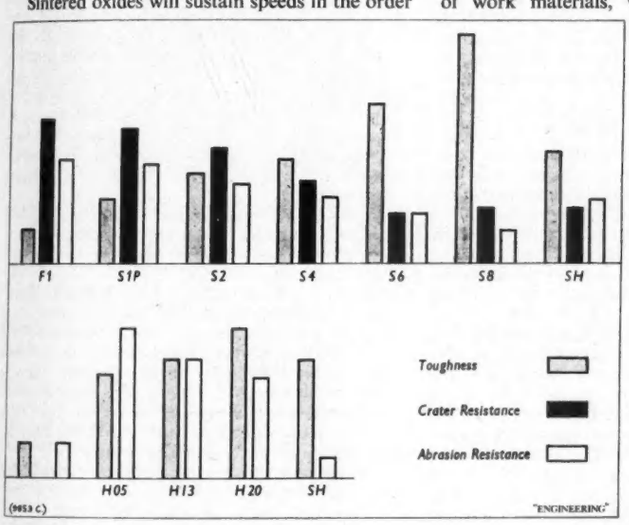


Fig. 3 (left) The toughness, crater resistance and abrasion resistance of various grades of tungsten carbide tool as supplied by one manufacturer.

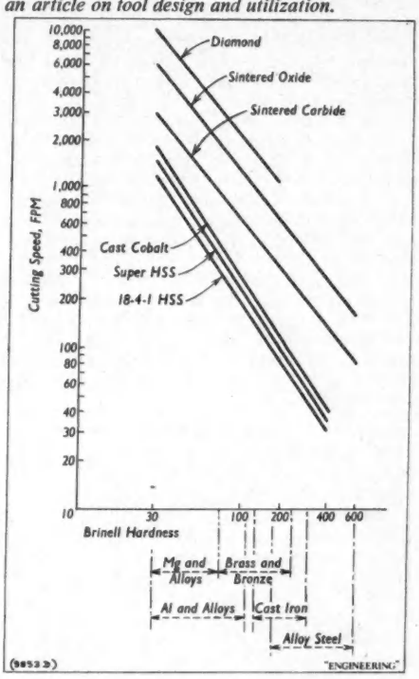


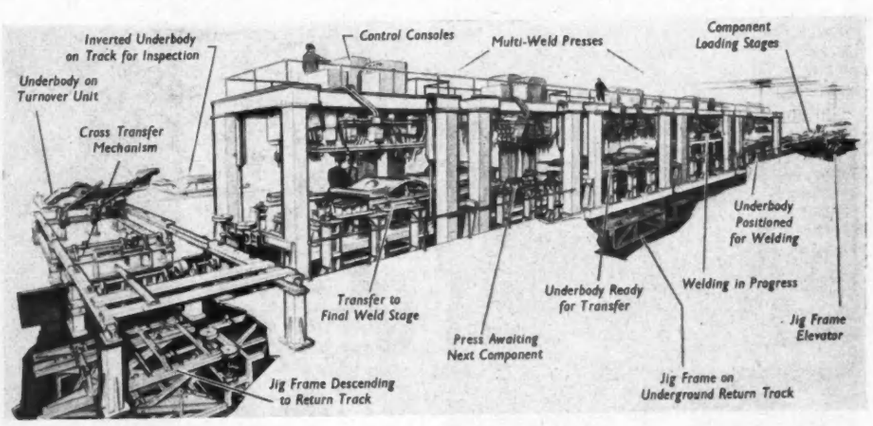
Fig. 4 (right) The work materials, with approximate cutting speeds, covered by the main classification of tool materials.

Multi-Weld Lines for Car Underbody Assemblies

In the mass production of integral car body shells, a serious problem is the manufacture of consistently accurate underbody assemblies. The Ford Motor Company are meeting this problem at their Dagenham factory by installing multi-weld assembly lines, as illustrated.

The separate parts making up the assembly are loaded into ten jig frames and passed through a series of five presses, each making some 150 spot welds between the floor pans and the floor frame members. Each press is a base, a platten and a crown supported on the base by four columns, the platten moving up and down hydraulically to bring the component to the welding guns suspended from the crown.

One line capable of producing one underbody assembly per minute is already in operation, and two others are being built. They have been designed under the direction of the Ford Motor Company's engineers by E. G. Urwin and Partners Limited, 2 Princes Row, Buckingham Palace Road, London, SW1.



High Tensile Wire Fit for Bridgework

The high tensile galvanized steel wire needed for the suspension road bridge over the Firth of Forth is the first of its strength to be produced in Europe. It now opens up exciting possibilities of its use in other directions.

THE £800,000 spent by Dorman Long (Steel) Limited on their Middlesbrough Wire Works during the past two years has more than doubled their production capacity and, more important, enabled them to make a major breakthrough in the production of high tensile steel roping wires. This breakthrough has been made necessary by the contract for 7,500 tons of parallel wire cable which is to support the 16,000 ton deck and additional traffic loading of the new Forth Road Bridge (ENGNG., 31 March, p. 453).

Now that this massive bridge project has provided an unprecedented (outside the USA, anyway) market, an unprecedented production line has become necessary. In its turn, the production line might make possible—even essential—other unconsidered markets. This, indeed, is the inevitable technological evolution, with production processes and markets leapfrogging and catalysing each other until none can ever know where the ultimate lies. If "truth stands on a hill, craggy and steep," then, in engineering, the cragginess and the steepness are finally insuperable but immediately stimulating.

In this case, the stimulation has resulted in a production line that makes galvanised steel wire with a tensile strength of 100 to 115 tons and in continuous coils of such weight, approximately 1,000 lb, that even American engineers, the world's most experienced in this field, have been surprised.

THE PROCESS

The controlled production process begins at the Lackenby Rod Mill with a high carbon steel billet which, in its entirety, becomes a coil of first rod and then wire. A stringent quality control system, operating from the initial blast furnace to the final galvanizing, requires that this billet shall always retain its separate identity, through its cast number, so that any fault developing in it is known to originate in that billet or coil alone. This quality control appears to be effective, for less than 1 per cent of production has been rejected as not meeting the exacting final specification.

As far as the wire works proper is concerned, the raw material consists of coils of 0·400 in diameter steel rod with a carbon content of 0·75 to 0·80 per cent and a manganese content of 0·50 to 0·70 per cent. These rods are delivered by rail wagon and deposited on the goods inward off-loading stage in two upright rows by an overhead crane. From there, they are picked up in approximately 30 cwt batches by a fork lift truck, fitted with a single pin instead of the conventional forks, and delivered to the beginning of the production line.

After being tested at both ends for internal and external defects, the coils are placed on turntables or "swifts" to be fed to the initial heat treatment process, known as "patenting." The swifts each carry two coils, lying flat, with the lower coil being fed into the furnace. When the lower coils have been unwound from the swifts, collapsible arms drop the upper coils to the lower level ready for treatment, making for a minimum of changeover time and high utilisation of the furnace.

TABLE:—*The Final Specification*

Diameter, 0·196 in $^{+\ 0\cdot003\text{ in}}_{-\ 0\cdot002\text{ in}}$ tolerance.
Tensile strength, 100 to 115 tons per sq. in (with an average tensile of not less than 102 tons per sq. in).
0·2 per cent proof stress, 75 tons per sq. in minimum.
Elongation, 4 per cent minimum on 10 in gauge length.
Wrapping test, on three times wire diameter.
Hot dip galvanised to BS 443.
A 100 ft length under a tension not exceeding 300 lb must be "perfectly" straight.
Coil weight, 850 to 1,050 lb.

A batch of 24 wires is fed through the 60 ft patenting furnace at a time, being heated to 950° C and passing four electronically controlled zones. They are then quenched in molten lead at 510° C and passed through rollers to crack their surface scale before being rewound into coils.

At this point, the rods are again tested, this time for a tensile strength of 72 to 78 tons per sq. in, an elongation of 8 per cent minimum on 10 in gauge length, and a reduction of area of 30 per cent minimum.

FIVE DRAFTS

The heat treated rod is then "pickled"—in an unusually clean pickling house—by immersion in a dilute solution of cold hydrochloric acid for 30 to 40 minutes. The same crane then delivers the same batches to further dips for (*a*) high pressure water washing, (*b*) phosphate coating, and (*c*) immersion in boiling lime. Afterwards, the coils are baked dry in gas ovens as a precaution against rusting.

Now the rods are ready for wire drawing. First, they are butt welded together to provide a continuous flow through drawing and the welds are marked with yellow paint for quick identification when they are to be cut out again after the operation. The continuous flow is then fed from a bank of three swifts to five successive drawing dies. These dies are of tungsten carbide encased in mild steel and lubricated by soap powder (Brand X, one likes to think). The five drafts reduce the 0·400 in diameter rod progressively to 0·192 in diameter wire at a finishing speed of 630 ft per minute.

The drive through the drafts comes from capstans between the dies, tension control being incorporated so that any stopping and starting cannot harm the product. After drawing, the wire is force cooled on the last capstan drum by water on the inside and air on the outside. The welds are then cut out and the wire, as the material has now become, is rewound in separate coils.

Once again the wire is tested and at this stage must have a diameter of 0·192 to 0·195 in, a tensile strength of 113 to 120 tons per sq. in, and an elongation of 2 per cent on 10 in gauge length. It must also pass a severe wrapping test on its own diameter.

GALVANIZING

The wire then passes forward to the hot dip galvanizing operation, feeding into it, 18 wires at a time, from double decker swifts similar to those used before patenting. Galvanizing entails a number of preliminary operations through which the wires must pass. The first of these is a gas-fired low-temperature lead bath, at 435° C, which burns off excess wire drawing lubricant and stress relieves the wire. Next there is further pickling, this time in hot hydrochloric acid, to ensure good zinc adhesion, followed by a double water wash and the flux bath which is necessary before the actual zinc coating.

The galvanizing bath itself contains 40 to 45 tons of molten zinc of 99·98 per cent purity maintained at 435° C. From the bath, the wire passes vertically through a wiping bed of oiled charcoal to give a smooth surface finish.

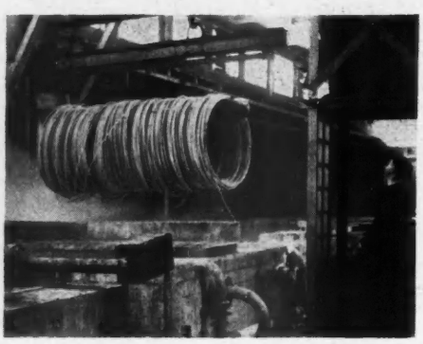
A particular innovation in production for the Forth Bridge contract is that after passing through the wiping bed the wire continues vertically for 35 ft before passing over a 5 ft diameter pulley and down to be recoiled on 5 ft diameter winding blocks. The objects of this high ascent are to ensure adequate cooling and to assist in meeting the Forth Bridge specifications on straightness.

Under final testing, which is supervised round the clock by an independent inspection authority, the wire must meet the strict specifications shown in the table.

The finished coil is also wrap tested at both ends around three times its own diameter and the zinc coating is tested both volumetrically by its reaction with hydrochloric acid and for concentricity by dipping in copper sulphate. Identifying labels on each coil indicate its cast number, coil number, size, weight and whether it is right or left hand wound. Thus, any coil can be traced back through its entire history.

The coils are then stored in plaited stacks under polythene in a dehumidified atmosphere (ENGNG., 31 March, p. 349) until required at the Forth. Once spinning starts at the bridge site, wire will be dispatched there by rail at a rate of 800 tons per week.

Later on, wire from the same shop will almost certainly be used for the Severn, and, maybe, for the Humber and the Mersey bridges.



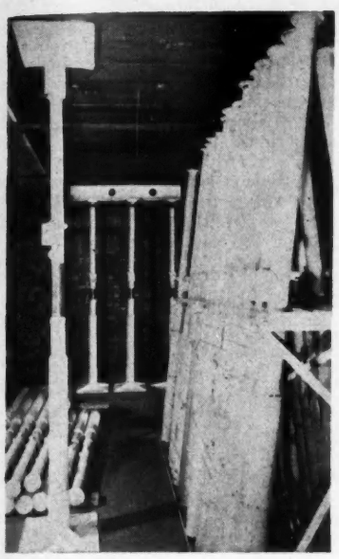
(Left) The dipping crane used in the pickling house. The operator travels alongside it in a mobile cabin.

(Right) The wire drawing section. Rod is fed in from the far end and emerges as wire at this end.

Exhibition Prop

Diversification in the use of a standard product has been taken to an interesting extreme in the case of the Dowty hydraulic pit prop. Of the 2,000,000 props turned out by Dowty Mining Equipment Limited in the past 14 years, few can have been put to more unexpected use than those now supporting the exhibition floors at Olympia.

Like the current Engineering, Marine, Welding and Nuclear Energy Exhibition, many other well known exhibitions are held at Olympia during the year. To improve the facilities available to exhibitors, it has been necessary to increase temporarily the strength of the exhibition



Hydraulic props installed (left) and stored (right).

hall floors to enable very heavy exhibits to be moved and erected without damage to the floors and basement areas.

Dowty engineers have evolved a flexible system which is approved by the LCC District Surveyor. During trials, 12 props were set at a ½ ton pressure and two mobile cranes totalling 20 tons in weight were parked on the hall floor immediately above the hydraulic supports. The indicators on the pressure gauges confirmed that without floor deflection the weight was transmitted to the basement floor and, when the two cranes were removed, the pressures returned to their original settings.

Basically, the Dowty pit prop consists of two telescopic steel members extended by means of hydraulic fluid. There are six standard models which, with specified fixed extensions and hydraulic travels varying between 6 in and 24 in, give a range of 25 props between 21 in and 92 in extended length. The height of the basement ceilings at Olympia necessitates extending the props to 10 ft.

Hydraulic props are now being used by construction engineers for temporary support of buildings during alterations. They are also well suited to providing such support during some types of heavy production work.

Tubes Cut Faster by Machine

Birwelco Limited, of Birmingham, are now using a British Oxygen Alyn Mark 1 tube cutting machine to cut and prepare pipe ends for welding in one-seventh of the time formerly taken by the hand cutting and grinding method. For example, it used to take at least half an hour to prepare a 2⅜ in pipe, but this job is now completed in less than four minutes and the actual cutting time is about 40 seconds.

The Alyn machine has eliminated the need for templates and for marking the line of cut on each job. Instead, selection of the profile now takes only a few seconds and is done simply by adjusting a handwheel. The same setting can then be used for any number of repeat cuts.

The Mark 1 used by Birwelco in the production of flange weld necks can cut pipes from 2 in to 4 in diameter. A larger machine, the Alyn Mark 2, handles pipes from 4 in to 12 in diameter.

From Sewage to Wet Paper

Engineers at Dartford Paper Mills, Kent, appear to have overcome the two big problems—water in the electric motor and air locking—which make the pumping of wet paper a difficult business. Their solution has been to adapt a 5 hp Flygt CS 100 submersible electric sewage pump, a single compact unit which normally operates in sewage sludge.

The pump is used to raise paper stock from the chest, where it is kept in a state of agitation, up to the headbox, from which the stock is transferred to the production line. The height from the discharge vent of the pump to the headbox is 27 ft and the CS 100 pumps approximately 150 gallons of paper stock per minute against this head. Since its installation 18 months ago, the pump has been running right through the three daily shifts, has had no maintenance, and its only rest has been when the mill has closed down during every second weekend.

The pump's encapsulated water-proof electric motor and its ability to run indefinitely "on snore" make it, in the experience of this particular firm, superior to the horizontal pump conventionally used for paper stock. A major failing with conventional pumps has been their tendency to suffer air-locking because the paper stock in the chest must be kept in a state of agitation.

Dartford Paper Mills purchased two CS100 pumps, one being kept in reserve. If there should ever be any failure of the pump now in operation—a most unlikely event, they believe—it would be a quick and simple operation to replace it with the spare. This operation would involve removing the four bolts in each of the two flanges and transferring the power attachment to the new pump.

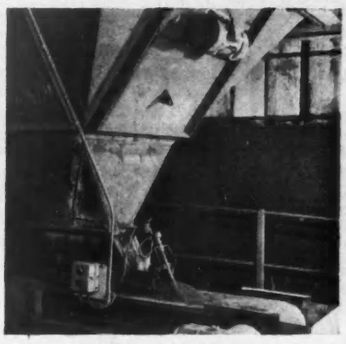
Vibrator Motor Helps Materials Handling

A simple and effective solution to the frequently met problem of how to dislodge material stuck to the sides of a hopper has recently been found in a series of experiments with an English Electric vibrator motor. The experiments were made on a hopper handling filter cake at a fertiliser factory in the north of England.

In the manufacturing process, the filter cake flows from the hopper on to a short feeder conveyor incorporating an electronic probe which detects whether or not the material is in fact flowing. Before the vibrator was installed, the detector operated an alarm which gave an audible signal when the flow stopped. An attendant then had to climb steps from the factory floor to the hopper platform and hit the sides of the hopper with a hammer to start the flow again. The moisture content of the material varies considerably and under certain conditions this action was necessary at frequent intervals.

Not only did this interfere with production, but it also caused severe damage to the sides of the hopper. It was, in fact, necessary to renew the side panels from time to time, which meant emptying the hopper, burning out the damaged panel and welding in a new one.

In the first experiment, a ¾ hp 3,000 rpm vibrator motor was bolted to a ¾ in steel plate of about twice its own length, and the complete assembly then bolted at its extreme ends to the side of the hopper about half way up. The



A general view of the filter cake hopper showing the vibrator motor and the automatic probe detector.

resultant "flapping" effect at the centre of the plate against the hopper was sufficient to maintain the flow of material. A short burst of a few seconds duration every few minutes was found adequate.

Further experiments were carried out to produce a completely flexible system of operation and in the final installation three methods of control were incorporated.

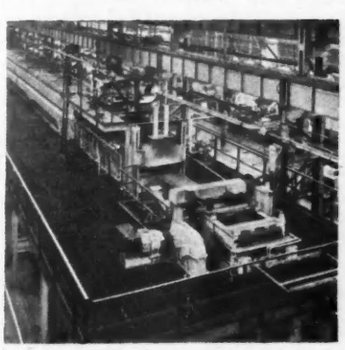
These were a manual push button starter under the control of the operator, a timer unit which automatically operates the motor for 10 sec every 10 minutes, and a relay controlled by the electronic probe which operates the vibrator in the event of an interruption of the flow of material between the automatically timed bursts.

These three methods of control are connected in parallel and are, therefore, supplementary. The installation maintains the flow of material without attention.

Electric Annealing and Decarburising

Electric furnaces which have the advantage of providing close and accurate control are being used more and more widely in steel production. Recently, the General Electric Company Limited supplied Richard Thomas and Baldwins Limited with a number of such furnaces for the processing of Alphasil, a silicon steel of the grain-orientated type used in cores for transformers and reactors.

The furnaces, which are installed in the Cookley Works at Brierley Hill, near Birmingham, consist of continuous strip decarburising and inter-annealing furnaces, together with bell-type furnaces for high-temperature annealing.



The 2,000 kW continuous-strip inter-annealing furnace from the entry end.

Including the cooling chambers, the decarburising furnace is nearly 400 ft long and is believed to be the longest of the roller hearth type in Europe. It handles steel strip up to 32 in wide. The inter-annealing furnace is of similar design but its maximum electrical rating is 2,000 kW compared with the 1,700 kW of the decarburising furnace.

A New Guide to 25,000 British Firms

"Kompass Register" is the name of an entirely new reference directory which will make more accessible than ever before the details of about 25,000 United Kingdom firms, their products and services.

THE key to the exceptional coverage and detail of Kompass Register is a unique method of presenting a vast amount of information in a small space. A "grid" method of presentation, which is illustrated below and is described later, gives an immediate indication of all manufacturers, or wholesalers, of a given product. At the same time it provides information on all the products of a firm within a given class.

In almost every country in Europe a Kompass Register is now being produced or has already been published. It originated in Switzerland, where ten editions of the Swiss Kompass have been published. In Britain a new edition will be published every year, and the special methods of printing will enable any changes in the information about firms and their products to be incorporated right up to the eleventh hour before going to press. The information will therefore be more up-to-date, as well as more comprehensive, than the information available from conventional directories.

Kompass Register will also make the information easier to get at. Judged by the number of new specialised journals which clutter up the market every year, there is no shortage of information of one sort or another. But it seems that the user is seldom considered: publishers too often take it for granted that if they publish information there will always be readers to read it. Insufficient attention is paid to the needs of the reader of a periodical or the user of a work of reference. Kompass clearly offers a unique service in this respect. The information it provides is exceptionally comprehensive and accessible. For this reason, Engineering Limited, publishers of ENGINEERING, have associated themselves with Brown Knight and Truscott Limited, the printers and lithographers, in establishing Kompass Register Limited, the publishers of the new work.

WELCOME

The establishment of Kompass in Great Britain has been welcomed by the Board of Trade and by other bodies concerned with trade at home and overseas, including UNESCO, United Kingdom Chambers of Commerce and numerous trade associations. Copies of Kompass will be sent to all United Kingdom trade posts abroad. For public and special libraries it will be an invaluable reference work.

Just a year ago the first full-scale field work on the compilation of the Register was carried out in the Bristol area. That area was chosen largely because in it is to be found a representative sample of industry and commerce, in a pattern which is closely typical of the country as a whole. The experience of the pilot work there confirmed the publishers' conviction that they were embarking on a worthwhile project.

AT EXECUTIVE LEVEL

Field work throughout the country is now in full swing. More than 50 district information officers have been recruited, and between them they are visiting every company personally. The object is to obtain thorough, detailed and accurate information. Their approach to firms is at executive level, and for this reason the district information officers are men of considerable experience and intelligence, many of them with a sound background of administration, and all of them specially trained by the publishers. The managing director of Kompass Register Limited, Mr. M. Gordon, is an accountant by profession, with experience in management consultancy, business organisation, and sales management. In the company's new offices in the City of London a large staff of editors is now engaged on the immense task of compiling the first edition, which is due to be published in the spring of 1962.

In every European country where Kompass is being produced, the publishing firm is independent of the Swiss company. But there is close collaboration between all the publishers concerned, so as to ensure an adequate degree of uniformity among all the registers and so that the standard of excellence of the work will continue to be improved. The United Kingdom Kompass will present the entries in five languages, and it will become one of the "family" of European registers. Thus every national edition of Kompass will be circulating throughout the other countries, and the UK edition, for example, will become an important instrument in the expansion of British home and overseas trade. Copies will also be going to Commonwealth countries, the United States and elsewhere abroad. At home, Kompass will be the nearest thing to a Domesday Book of 20th century industry and commerce that has ever been undertaken.

This is how the user of Kompass finds the names and other details of the manufacturers (or wholesalers) of a given product. Suppose he is looking for manufacturers of polarimeters. He finds the work in the Product Index, which is alphabetically arranged, and against the word a code number is given: 39 03 24. He then opens the register at the thumb index mark of the first number (39). In the Swiss edition, from which this illustration is taken for convenience, 39 is the code number for "precision machines." There, under the second number (03), he finds a sub-classification headed "Astronomical and Optical Instruments and Apparatus," which includes polarimeters. On the same page is the "point grid," a section of which is illustrated below. By running his eye down the column given by the third number (24), he finds the names of all the manufacturers (indicated by a black spot) and the wholesalers (indicated by a triangle). For full information on any of these firms he can turn to the company information section of the Register, which in the UK edition will be arranged by county, town and name.

All the basic information in Kompass is to be published without charge to firms. This includes not only complete details of products manufactured, supplied or distributed and/or services offered, but also the following information:—

Registered name,
Full address,
Telephone number and number of lines,
Telegraphic address,
Cable codes,
Telex number,
Banks,
Normal business hours,
Location (simple directions for finding the firm),
Directors/partners/proprietor,
Executives,
Share capital,
Number of employees.

A charge is made for entering additional information under the following headings:—

Generic heading of activities,
General description of the company's manufacture, etc.
Trade names,
Head office and registered office (if different from address given already),
Branches or factories,
Subsidiary companies,
Associated companies,
Membership of a group of companies,
Membership of trade associations,
Agents or distributors at home and abroad,
British agents for foreign firms or agents for other British manufacturers,
Year established and a short history of the company.

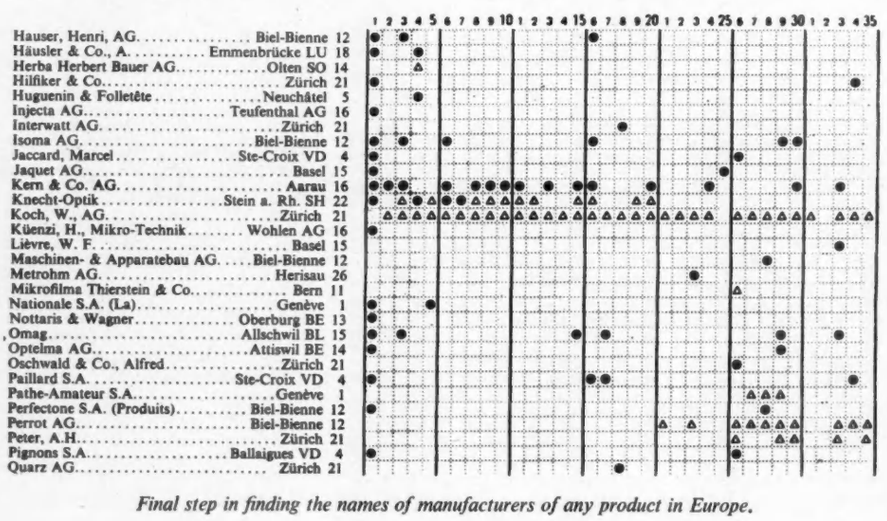
The UK Kompass will give details of all manufacturers with more than 50 employees, as well as many smaller firms which are subsidiaries of larger firms or which are specialists worth mentioning. The principal wholesalers, merchants, and commercial services (banks, insurance, consultants, etc.) will also be included. It is estimated that this coverage will produce about 25,000 firms, and as many as 30,000 or 40,000 products. The UK Kompass will probably be published in three volumes, which between them will contain a few million items of information.

Techniques of printing which are new in this country are being used for producing Kompass. They will keep the cost of the finished work down to a reasonable figure.

Great care is being taken over translation into foreign languages. A central translation bureau has been set up in Zurich, which distributes the work to specialist translators in the country of the language required, thus ensuring that the final wording is chosen by a person who is using his native language.

The Swiss, Swedish and Spanish editions are already available in Britain. Kompass is also being prepared in the following European countries: Germany, France, Italy, Austria, Belgium, Denmark, Holland and Greece, as well as the United Kingdom.

The complete UK Kompass Register will cost £15 15*s*. A 20 per cent discount is allowed for subscriptions placed before publication date. *Kompass Register Limited, Therese House, 29-30 Glasshouse Yard, Aldersgate Street, London, EC1.*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Hauser, Henri, AG. Biel-Bienne 12
Häusler & Co., A. Emmenbrücke LU 18
Herba Herbert Bauer AG. Olten SO 14
Hilfiker & Co. Zürich 21
Huguenin & Folletête Neuchâtel 5
Injecta AG. Teufenthal AG 16
Interwatt AG. Zürich 21
Isoma AG. Biel-Bienne 12
Jaccard, Marcel Ste-Croix VD 4
Jaquet AG. Basel 15
Kern & Co. AG. Aarau 16
Knecht-Optik Stein a. Rh. SH 22
Koch, W., AG. Zürich 21
Küenzi, H., Mikro-Technik Wohlen AG 16
Lièvre, W. F. Basel 15
Maschinen- & Apparatebau AG. Biel-Bienne 12
Metrohm AG. Herisau 26
Mikrofilma Thierstein & Co. Bern 11
Nationale S.A. (La) Genève 1
Nottaris & Wagner Oberburg BE 13
Omag. Allschwil BL 15
Optelma AG. Attiswil BE 14
Oschwald & Co., Alfred Zürich 21
Paillard S.A. Ste-Croix VD 4
Pathe-Amateur S.A. Genève 1
Perfectone S.A. (Produits) Biel-Bienne 12
Perrot AG. Biel-Bienne 12
Peter, A.H. Zürich 21
Pignons S.A. Ballaigues VD 4
Quarz AG. Zürich 21

Final step in finding the names of manufacturers of any product in Europe.

Nuclear Investment

INTEREST in the nuclear industry is reported to be stagnated, but out of the 500 stands at the Engineering, Marine, Welding and Nuclear Energy Exhibition to be held at Olympia from 20 April to 4 May, approximately 40 per cent will be exhibiting a product relevant to the nuclear industry. The number of firms that have joined the initial "gold rush" in nuclear energy is large, as the proportions at the exhibition illustrate. So long as the interest prevails, there will be keen competition when nuclear power becomes economic.

Details of Some Exhibitors

Associated Electrical Industries Limited will be showing large ignitron valves used in nuclear research.

Aiton and Company Limited will exhibit corrugated piping of 18 in inside diameter for use in the carbon dioxide cooling circuit at Trawsfynydd.

Babcock and Wilcox Limited have models of their steam raising plant for ships and the 580 MW nuclear power station at Sizewell.

Keith Blackman Limited now manufacture axial fans with slotted blades, similar to those fitted in American nuclear submarines. The slotted blade formation gives improved boundary layer control and extends laminar flow further over the blade chords—giving higher efficiency and high operating pressures at low speeds.

Bristol Siddeley Engines Limited will show gas bearings and pumps, and ball screws (screws with ball-race assisted threads) widely used in precision control systems.

The Gammacell 220 irradiation unit which is to be shown on the Canadian Government stand has a fixed source of up to 54 cobalt rods arranged in "squirrel cage" formation round a 6 in diameter, 10 in high irradiation chamber.

"Caposite" amosite asbestos and "Rocksil" rock wool are exhibited by Cape Insulation and Asbestos Products Limited. These two materials are used to lag the pressure vessels and gas ducting at the Berkeley nuclear power station.

CAV Limited will be showing an electrically operated 18-position rotary selector gas valve used in the burst slug detection equipment.

The Esso Petroleum Company and Castrol Industrial Limited have ranges of radiation resistant oils and greases to show.

Two new components by Flight Refuelling (Holdings) Limited will be exhibited for gas circuits of 2½ in nominal bore, working at 240° C and 300 lb per sq. in. One is a remotely controlled in-line shut-off valve automatically closing in the event of an electrical failure; the other is a self-sealing hose coupling which can be connected up and the valve opened against line pressure, with automatic "throw out."

A model of the "hot" handling facility at the CEGB's Berkeley nuclear laboratory. There are three large caves where the fuel elements are machined and stripped, and ten smaller caves are used for handling the samples to make a more detailed examination; the master slave manipulator has been designed by H. M. Hobson Ltd.

Nuclear Engineering Limited will cover information on their "Automatron" irradiation units which will hold a cobalt 60 source up to 50,000 curies for the H1 model, or up to 10,000 curies for the T2 model.

A new type of restraint mechanism for accommodating thermal expansion in high pressure and high temperature piping systems has been developed by Richardsons, Westgarth and Company Limited. It will be used with conventional bellows convolutions at Trawsfynydd. It consists of a large number of high tensile rods grouped in two frusto-conical assemblies round the periphery of the pipelines. Another constraint assembly of five concentric tubes with a mild steel tie rod inserted in the central middle rod will be shown by the Talbot Stead Tube Company Limited.

Short Brothers and Harland Limited are showing a scale model of the reactor simulator with a capacity for 200 amplifiers and an overall component error of less than 0·1 per cent. A similar machine is being installed at the Calder Hall Operations School.

Simmering-Grax-Pauker AG have supplied 80 per cent of the mechanical components for the 5 MW ASTRA research reactor at Seibersdorf and the 100 MW TRIGA reactor that is located at Vienna.

The Talbot Stead Tube Company Limited will also include exhibits of breeder thermocouple guide tubes, a model of a stainless steel control rod with boron inserts. A model of a mild steel

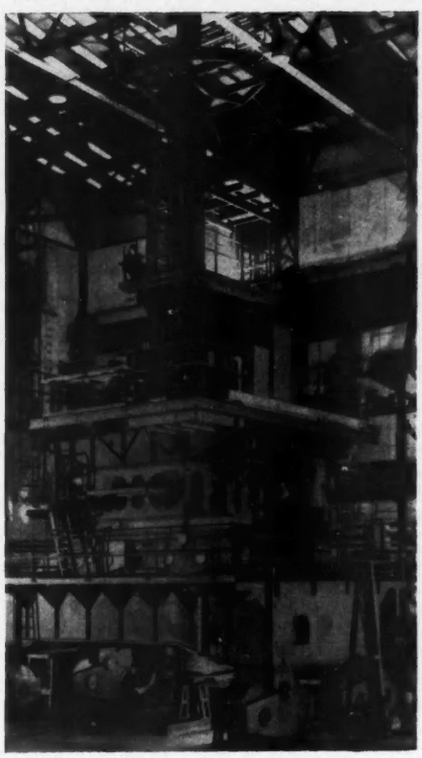


Fig. 1 Charge-discharge machine for the Advanced Gas Cooled Reactor undergoing the final test at the Chesterfield factory of Markham and Company Limited, prior to dismantling for dispatch to Windscale.

charging standpipe will be included, the upper portion consisting of a concrete-filled outer tube containing four tubes, while the lower portion has a large tube with a smaller tube fixed to the outer wall.

Charge Discharge Machine for Windscale

Final tests are being completed on the charge-discharge machine for the advanced gas cooled reactor at Windscale. The machine has been designed by John Brown (SEND) Limited, the main contractors, in conjunction with the United Kingdom Atomic Energy Authority and has been built by Markham and Company Limited. Within the next two weeks the machine, shown in Fig. 1, will be dismantled and transported to Windscale. The components have been designed so that they will all pass through the 10 ft entry chamber into the reactor; it will take about four months to reassemble the machine inside the vessel, and the schedule calls for the machine to be finished by October. The machine will remove spent fuel elements and replace new ones while the reactor is running under full load and pressure. Under these conditions the machine is capable of removing and replacing three fuel element stringers a day; this number may be increased when the reactor is shut-down.

Accuracy in Positioning the Machine

The machine is 65 ft high and weighs about 400 tons, and the normal handling pressure vessel is 2 ft diameter and 56 ft long, supported vertically on a superstructure built up from a crab and gantry. There is also another pressure vessel for emergency use in case an element breaks and it includes special handling devices and instruments for interior observation including a television camera. The special handling facility is designed to operate at atmospheric pressure. A feature of the machine is its ability to position itself to within 0·005 in of the desired position. In experiments over the last week it has been found that positioning to within 0·002 in is possible; Markhams claim that this has been made possible by use of a unique servo-system which is being patented and a suitable electronic and mechanical system to follow.

Sequence of Operation

The refuelling operation begins with a manual connection between the machine and the fuel plug string. A nose is then extended from the handling vessel to connect with the selected refuelling branch, which makes a seal between the machine and the reactor. The sensing equipment to achieve the accuracy for positioning the seal is the part that is also being patented. The spent fuel element is slowly withdrawn into the three position magazine in the normal handling pressure vessel, the magazine rotated, and a new fuel plug string lowered and locked into the reactor. During hoisting, the fuel element cooling system on the machine takes over from the reactor coolant circuit with no break, so that the spent elements are continuously cooled until their disposal. The normal handling vessel and cooling system each have a design pressure of 500 lb per sq. in, while the design temperature of most parts is 325° C, and in some cases 400° C.

Adequate shielding has been provided for both vessels by using 200 tons of cast iron for protection against gamma radiation and laminated wood to overcome fast neutron radiation.

New Dowty Seals

A new series of seals has been developed by Dowty Seals Limited of Ashchurch, Gloucestershire. A silicone compound SEM 895 has been used which, in addition to the normal sealing properties, has good heat resistance, withstands radiation, maintains its stability over a wide thermal range and resists compression set. A range of O-section rings have been produced withstanding temperatures up to 150° C when irradiated with high energy electron beams, and a further range of rectangular section seals for temperatures up to 175° C and for short periods up to 250° C. The new seals are suitable for use in the close vicinity of the reactor vessel, for example, standpipes and control equipment, where radiation is present and the temperature high. A further application is in "glove-boxes" where a sealing plug is fitted between the sectioned window frame and the aperature to which the handling glove is attached.

Simplified Instrumentation for TRIGA

A simplified instrumentation system for the TRIGA reactor made by the General Atomic Division of General Dynamics has been developed greatly reducing the number of components required. The system uses logarithmic and linear recording micro-microammeters obtained from a simple input-impedance conversion of standard recorders, a temperature compensated solid-state log network covering in excess of seven decades, and a novel period circuit. The count-rate channel and the rod position indicators are completely transistorised; the latter gives a reproducibility up to 0·2 per cent. A servo allows automatic start-up on a preset

period, and power regulation is better than 1 per cent. The complete system, including the four neutron channels, may be put in a desk-top cabinet.

A New Robot

The Mobot Mark II (Fig. 2) made by the Hughes Aircraft Company has three joints in each arm—the shoulder, elbow and wrist. The joints are operated by electrical actuators controlled by the operator who manipulates toggle switches. There are pedals to regulate the speed of the vehicle and the speed of the arm movements. The system is planned to be used with two screens monitoring TV pictures at the

Fig. 2 The new Mobot Mark II made by Hughes Aircraft Company.

operator's console. Microphones have been placed at the wrists to allow the operator to listen to the tasks being performed by the machine's hands.

High Intensity Radiation Development Laboratory

Construction, expected to last about one year, has begun on a High Intensity Radiation Development Laboratory (HIRDL) at the Brookhaven National Laboratory. It is designed to advance the Commission's programme for process radiation development, and is estimated to cost, including equipment, $1,850,000. The total area of the building will be approximately 15,000 square feet. The new laboratory will be used to: (1) obtain engineering data on a variety of radiation sources in the million curie range; (2) develop more efficient techniques for handling large-scale radiation sources; and (3) train scientists and engineers in the uses of such radiation sources for research purposes and ultimately for industrial applications. The total level of radiation expected to be employed in the laboratory is approximately two million curies. Most of the sources will be of cobalt 60 and caesium 137; spent reactor fuel elements will also be used as sources of radiation.

Notes and News

Work Begins at Sizewell

The first phase of the 580 MW nuclear power station at Sizewell began on 4 April. After levelling the ground, over half a million cu. yd have to be excavated. By the beginning of July detailed excavation of the reactor foundations should be well advanced. The present labour force is about 300 but this will rise to about 2,500 in 1962, some of whom will have living quarters on the camp site.

Work has begun on the two 63½ ft diameter pressure vessels, boilers and ancillary ducting and piping at the Renfrew and Dalmuir works of Babcock and Wilcox Limited.

New Uranium Plant

Senator de Klerk, the Minister of Mines in South Africa, last week officially opened a pilot plant for the production of uranium metal and salt at Johannesburg. The plant went into operation last November and will be able to cater with 100 tons of uranium per annum. The Minister said that he hoped the plant would help South Africa economically, since instead of receiving a smaller profit for the export of the uranium ore they would not be able to accept orders for the refined metal at a much better price.

Portable Gamma Ray Spectrometer

A portable gamma ray spectrometer has been devised comprising a single channel scanning pulse-height analyser, high voltage supply photomultiplier tube and sodium-iodide crystals was described at the seventh Scintillation Counter Symposium in Washington. The circuits are transistorised and driven from rechargeable batteries. The analyser contains a linear amplifier, window discriminator, count-rate circuit and miniature recorder. The recorder and window discriminator are driven synchronised to display a spectrum in twelve minutes.

Classification of Nuclear Ships

During the last few years, numerous International meetings have been held in an attempt at determining the general safety requirements for nuclear ships. A new contribution was recently given to this research in the symposium at Taormina (Sicily) last November, organized by the International Atomic Energy Agency in cooperation with the Inter-Governmental Maritime Consultative Organisation.

One paper discussed the prospects of framing regulations governing the classification of nuclear ships; the authors, Mr. Bourceau, Bureau Veritas Chief Engineer, and two colleagues, aimed at establishing a frame of technical cooperation between the yard building a nuclear ship and Bureau Vertias in view of the classification of such a ship.

Bureau Veritas Nuclear Energy Commission

In establishing international regulations, the 1960 Conference on Safety of Life at Sea held in London considered the main problems arising from the use of nuclear propulsion. It seems appropriate also for an International Classification Society which, since 1828, has kept pace with the technical developments in shipbuilding throughout the the world, to present their main views with respect to the framing of technical conditions to be applied to nuclear ships.

It may be recalled that, in 1958, a "Nuclear Energy" Commission was created within the Bureau Vertias Maritime Technical Committee, and during the first year after it was opened this Commission established an important working schedule. The authors of the paper above mentioned wishes to specify that most of the items which appeared had been taken from the reports made by the Commission and its working groups: a special mention is made of the contribution of the Commissariat a l'Energie Atomique and the Marine Marchande.

Establishing Guidance Notes

The authors emphasised the fact that establishing technical conditions applicable to nuclear ships was a much greater task than any of those performed before in shipbuilding. They insist that the almost total lack of experience in the matter leads to the formation of only "evolutive" technical conditions the relevance of which will be assessed in conjunction with the lessons learnt during the operation of the first nuclear ships. The paper indicates plainly that the authors do not intend to draw up "rules," even provisional ones.

The main purpose is to draw up guidance notes intended as a basis of discussion with the builder of every ship, thus admitting that the builder may propose different or new arrangements provided he gives reasonable justifications. The evolutive character of some of the technical conditions is particularly emphasised; it concerns particulars for which the authors wish to fix principles and, eventually, tender advice and draw attention to special difficulties: they clearly prefer to receive sufficient information to enable them to give their agreement as regards the safety rather than to prematurely fix "rules" which could not be justified by sufficient experience.

The main parts of the Bureau Veritas paper are (*a*) general technical conditions for nuclear ships and (*b*) two appendices giving particular technical conditions for the control of the reactors and main exchangers of the nuclear power plant.

A text has now been published by Bureau Veritas entitled "The General Technical Conditions for Nuclear Ships". Although the drafting is only provisional the conditions will be of assistance to the designer.

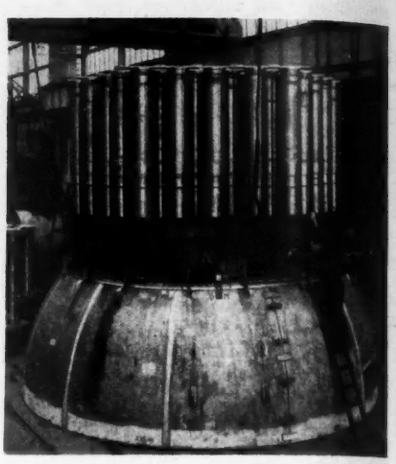


Fig. 3 Top dome of the HERO reactor vessel assembled at the Ashmore, Benson, Pease and Company Limited, Stockton-on-Tees, works prior to dispatch to Windscale. The vessel is made from stainless steel.

Reports Received: Instrumentation

Moderator Scattering Law: After discussing the problems and methods associated with the measurement of scattering laws, an experimental arrangement consisting of phased choppers and multiple detecting apparatus is considered the most favourable and treated in detail. ("The measurement of the scattering law for a moderator" by P. A. Egelstaff. AERE—R3593.)

Remote Handling: Some useful devices and techniques are described in connection with the radiochemical analysis of multi-curie level samples from the High Temperature Gas Cooled reactor loop irradiations. Details are given of a high level radiochemical cell which has been in use for about eighteen months. ("Remote handling and analytical techniques used in the processing of samples from HTGC loop irradiations," by P. E. Brown *et al.* AERE-R3252.)

Ionisation Chambers: A study has been made of the saturation characteristics of mean current ionisation chambers with gas fillings of neon, xenon and nitrogen in which the ionisation is due to fission fragments from uranium 235. A range of electrode spacings and gas pressures have been investigated and it is found that the best characteristics are obtained at the smaller electrode spacings and lower gas pressures. ("Saturation characteristics of mean-current fission ionisation chambers," by J. A. Dennis and W. R. Loosemore. AERE—M 566.)

Fast Neutron Counter: A proton-recoil proportional counter is described in which the counting rate is directly proportional to the estimated biological dose due to the fast neutrons in the energy range 0·1-14 MeV. The fast neutron sensitivity varies depending on the physical size of the counter. ("A fast neutron counter for dosimetry," by J. A. Dennis and W. R. Loosemore, AERE—R3302.)

Now Engines Run Hotter, Live Longer

Modern thermostatically-controlled cooling systems markedly reduce the period spent running "cold". This reduces corrosive wear. Anti-corrosive oils are no longer as important as they used to be.

"If you are buying a secondhand car, avoid one that has been owned by a doctor. It's not only heavily used but every day it makes a great many stops and starts. As it is left to cool down for 15 to 20 minutes at each stop, when it starts again severe wear of the piston rings and cylinders occurs—because of condensed acidic products that appear at low temperatures. No, don't buy a doctor's car, it will be much too worn."

This advice has been valid for a good many years of motoring. But it is not so any longer. In recent years coolant system design has progressed so that the doctor's car or the tradesman's delivery van can go through the day, stopping repeatedly for periods up to 20 minutes or longer without its temperature ever dropping down into the region where corrosive wear takes place.

Tests that confirm this are described in a paper, "Trends in Piston-Ring Wear in Automotive Gasoline Engines," by J. R. B. Calow and S. R. Epton. This paper was read before the Institution of Mechanical Engineers, being sponsored by the Lubrication Group.

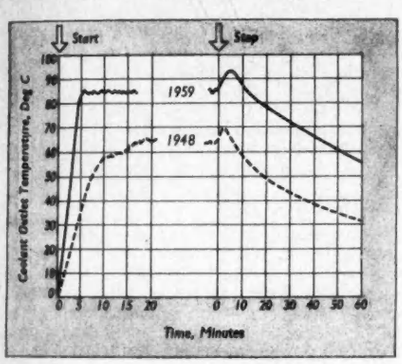


Fig. 1 The warm-up rate and operating temperature of a 1959 car well exceed those of a 1948 car. Cooling-down takes much longer.

The authors are with Shell Research Limited, Thornton Research Centre, Chester, and were interested in the subject because in recent years certain additive oils that had previously combatted corrosive wear were now not giving significantly reduced wear rates compared with non-additive oils. Apparently the mechanism of wear was changing.

NEUTRALIZING COMBUSTION ACIDS

During the 1930's research into piston-ring and cylinder-bore wear in petrol engines showed that most of the wear was caused by corrosive attack. Condensed acidic products formed by the combustion of the fuel were found to be responsible. This led, in the immediate pre-war and post-war years, to the development of certain types of additive motor oils. The oils contained metal salts of organic acids which reduced corrosive wear by neutralisation of the combustion acids. The additives usually combined dispersant and anti-oxidant properties with their alkaline characteristics.

A review of piston-ring wear rates obtained in field tests over the years show that they have grown smaller. To investigate the cause of this, the authors compared the wear rates obtained in laboratory engines under various conditions. Wear was measured as the total compression ring weight loss in milligrams per gallon of fuel consumed. The main point of interest was the effect of different water jacket temperatures.

The measurements made in the road tests showed a wide scatter, as is often the case. But the general trend agreed well with the laboratory experiments. Fig. 1 shows a comparison of the two sets of results. As can be seen, when conditions favour corrosive wear (low jacket temperature) the alkaline additive oils have a much greater effect.

The natural suggestion is that the observed lack of effectiveness of alkaline additive oils in modern cars is caused by running at a higher temperature. This implies that the wear rates are very low.

CARS TESTED

As no systematic information about rates of warming up and cooling down and mean operating temperatures of cars of various ages was available, a selection of about 50 cars of a fairly wide range of types and ages was taken and their coolant operating temperatures and rates of warming up and cooling measured by means of iron-constantan thermocouples and strip chart recorders. To represent starting-up and town driving, the cars were started and driven at 30 mph until the coolant outlet temperatures had reached their equilibrium levels. The rate at which an engine cools after stopping the car is also of considerable interest so this was also recorded.

The results of this investigation are summarised in the table. To assist in the interpretation of the results, the cars have been divided into four age groups. All cars produced up to and including 1948 form the first group; the majority of these cars are of immediate pre-war design as there was little change in the design of cars produced over this period. The second two age-groups, 1949-1951 and 1952-1955 inclusive, give a picture of the transition from pre-war to current design. The age-group 1956-1959 represents the current design of cars.

TABLE.—*Mean Engine Temperatures According to Age Group*

	Pre-war to 1948	1949-1951	1952-1955	1956-1959
Rate of coolant outlet temp. rise, °C per min.	4·6	5·8	6·6	8·9
Equilibrium coolant operating temp. at 30 mph, °C	69	72	75	79
Time to cool to 50° C, min.	24	44	48	50

The rate of coolant outlet temperature rise was estimated by dividing the difference between the mean maximum temperature reached and the ambient temperature by the time elapsing before the outlet temperature-time curve first flattened out.

The survey was carried out at a moderate ambient temperature of about 18° C. Similar measurements have been made at lower temperatures. The graph shows the difference in thermal behaviour between a 1948 and a 1959 car starting from an ambient temperature of 2° C.

It can be seen from the results that the modern car warms up more rapidly and takes considerably longer to cool down than its pre-war and immediate post-war counterpart. This seems to be mainly due to the displacement of thermosyphon cooling systems by water pumps and thermostats that isolate the engine from the radiator during the critical periods after starting and stopping, and which control coolant outlet temperatures at about 80° C. This change, in part, stems from the need to provide a high temperature water supply for interior car heaters, which are fitted more frequently nowadays as standard items than in the past. The effect of these changes is to make the modern car less susceptible to low-temperature corrosive wear.

CORROSION PRONE RUNNING

It is interesting to estimate the proportion of the time spent by an average modern car and by an older car running under corrosive conditions during a typical day. It is difficult to decide what is meant by a typical day's running but the test schedule involved seven short journeys of 15-30 minutes driving interspersed by stops varying from 30 minutes to 5 hours' duration. Using the results of the temperature survey in conjunction with this schedule, calculations have been made of the time spent per day running under corrosive conditions, defined as the time when the jacket temperature is below 50° C. The ambient temperature was assumed to be 10° C. On starting from ambient temperature it takes 4½ minutes for the coolant in a modern car to reach 50° C while in an older car it takes 9 minutes. Similarly during a stop of 30 minutes the modern car cools to 60° C whereas the pre-1949 car cools to 45° C.

Proceeding along these lines, it has been calculated that out of a total of 150 minutes running, a pre-1949 engine running to this schedule would spend about 46 minutes, or 30 per cent of its time, running under corrosive conditions; while a modern car would spend only about 17 minutes, or 10 per cent of its running time, in this region.

All the investigations referred to so far have been concerned with cast-iron compression rings. However, a recent survey has shown that many engine manufacturers are now fitting chromium-plated compression rings. Tests on these showed average wear rates about one quarter of those of cast iron; that is, rather less than 1 milligram per gal. Wear rates such as these are extremely low. It is assumed that the mean thickness of chromium-plate on the ring face is about 0·003 in. Then, if worn away at a rate corresponding to 1 mg per gal, the plating should last approximately 80,000 miles for the average car. If mileages of this order can be achieved before piston-ring wear becomes excessive and high oil consumption ensues, it is open to some speculation whether a major overhaul will become necessary before this point because of factors other than ring wear, for example, valve failure or bearing wear.

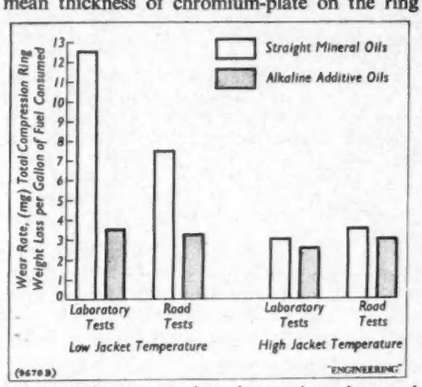


Fig. 2 Laboratory and road tests showed general agreement on trends in wear. Alkaline additive oils are clearly effective in corrosive conditions.

The authors' investigation was concerned with petrol engines. It does not follow that a similar situation exists in small diesel engines. The fuel acid yields, working pressure, and liner temperature distribution, are sufficiently different in the diesel to make it unwise to draw conclusions from the petrol engine experiments. It is likely that the higher pressures in diesels give rise to greater mechanical wear, owing to higher piston ring pressures, and this would give an apparent reduction in temperature effects.

What Users Want from Engineering Plant

An ENGINEERING *Survey*

To promote an exchange of ideas between users and makers of engineering plant, ENGINEERING has conducted an inquiry. The present article tells what improvements users are looking for; a second article will show to what extent manufacturers are meeting these requirements.

THE engineering used by engineers themselves is a theme particularly appropriate to the Engineering, Marine, Welding and Nuclear Energy Exhibition, which opens at Olympia next Thursday. Especially pertinent is the manufacture of engineering plant, and to give users the opportunity to influence the design of plant which they may one day wish to buy, ENGINEERING has conducted an inquiry. What improvements are users looking for? What new functions would they like equipment to fulfil?

Direct contact between manufacturer and customer, incidental to any purchase, does, of course, help to promote the development of plant: the customer submits specifications, and any shortcomings in the plant supplied are quickly drawn to the manufacturer's attention. But it is evident from the response to this inquiry that the exchange of information and ideas is not as thorough as it might be.

The replies by correspondents are summarised below, with comments. The cooperative and constructive way in which information has been volunteered is very much appreciated. But the response has been so great that we are unable to acknowledge all contributors by name, and rather than single out particular companies for mention, we have decided to refer to none. Instead, reference figures have been inserted in the text after every item so that the source may be identified in each case by reference to ENGINEERING.

Any manufacturer or reader who wishes to be put in touch with a company responsible for a particular suggestion or requirement should write to Deputy Editor (Planning), ENGINEERING, *36 Bedford Street, London, WC2, quoting the reference figure given in the text. The correspondent is also asked to indicate the type of plant or feature in which he is interested. Letters will be forwarded where requested.*

The article may also help visitors to the Engineering Exhibition to assess plant more critically and to select plant with features better suited to the applications which they have in mind.

Questionnaire

The inquiry was conducted as follows. Direct-mail letters enclosing a reply-paid questionnaire were sent to managing directors of 15,000 engineering firms asking them to comment on the features and improvements they or their technical staff would like to see incorporated in equipment falling into one or more of twelve categories. The twelve categories were boilers, diesel engines, compressors, pumps, gearboxes and transmissions, hydraulic equipment, pneumatic equipment, electrical equipment, conveyors, other mechanical handling plant, welding equipment and testing equipment. The questionnaire also asked whether the company were looking for a new machine or item of equipment (which might or might not yet exist) to perform a particular function. A description of the function was requested. So that users and manufacturers might be put in touch with one another, correspondents were asked to give their names and the names of their companies.

The report has been prepared on behalf of ENGINEERING by Mr. J. C. Veale, M.Eng., A.M.I.C.E., M.I.Mech.E., who is himself concerned with the operation of engineering plant. He is a fellow of the Institution of Plant Engineers and a member of the Institute of Fuel. Our second report will summarise the replies of manufacturers to views expressed in the present article.

Points taken from replies have been treated under the same headings as were tabled in the questionnaire, but beginning with some general comments applying to all categories and ending with several sections devoted to features and equipment not embraced by any category listed.

All Plant

"We have no suggestions to offer. The equipment we are using seems to be entirely satisfactory"[1]. This is actually one of the replies received. It is not typical. We did not expect it would be; otherwise there would have been little point in making the survey. However there were at least three others with a similar outlook: "Any plant or machinery in use is of the conventional type; and no special features are required"[2]; "As a comparatively small concern our needs are met from available equipment"[3]; "No comment—we have always been able to purchase suitable plant for our particular needs"[4].

As users we should all like to have cheaper plant and better delivery times. A number went so far as to say so in reply to the questionnaire: "Our problem is primarily cost, delivery and in some cases service on most items of equipment. The number of sources is also limited"[5].

Under the respective headings "Type of plant" and "Nature of improvement" one contributor wrote "All—much cheaper"[6]. This was his only contribution. Another wrote: "All—Price"[7]; and another: "General—smaller size—lower weight—price saving"[8]. In similar vein: "All types—in general we are satisfied with the plant we purchase, but would like to have it smaller, lighter, cheaper and with a better delivery"[9]; and: "generally no difficulties in finding the plant we require to meet our needs. Lower prices and quicker deliveries would be the most useful improvement. More standardisation and bulk production could surely lead to this"[10]. Another reply was rather similar: "General equipment—improved deliveries or at least maintain specified delivery. More standardisation and interchangeability"[11].

Not maintaining specified deliveries is too common a fault. Sometimes it can be self-adjusting to a certain extent in that the supplier will lose business and consequently have to do something to improve his deliveries (or the accuracy of his promises). Unfortunately the fault may result in business being lost to other countries. When this happens on a substantial scale the economy of the country may be affected; thus the individual purchaser in Britain may be affected adversely both directly and indirectly by a manufacturer who fails to keep his promise.

Returning to the question of standardisation, another comment supplied a possible reason for standardisation not being more popular than it is: "Generally speaking we have some difficulty in locating *standard* production plant suitable to our needs. We are 'one-off, special type' people! We also frequently find that equipment is getting too complicated for the smaller type of firm, where capital expenditure has to be carefully controlled and where complexity of design can mean high cost"[12]. Similarly: "At present we are not looking for plant but, owing to small demand, we have more or less to design our own or adapt from some other trade"[13]; and "No difficulty in finding equipment to meet our needs except for specialised items for our own trade which we design and make ourselves (mainly test equipment)"[14].

The following reply is also related to the question of standardisation: "In general we have found that British manufacturers are not interested in building one-off machines or even in modifying standard types to meet special needs. This refers to testing equipment (mainly electrical) and welding equipment (resistance welding only)"[15].

An interesting criticism called for better knowledge by the sales department of their own company's service organisation, particularly with respect to breakdown service[16]. One suspects that thereby hangs a tale—perhaps several tales. The user's name is mentioned with his permission to quote, so any manufacturers with guilty consciences are at liberty to inquire.

A generally superior finish in all the categories of plant was called for by one user[17]. Another, probably referring to hydraulic equipment, expressed the hope that equipment would be more reliable than at present[18].

An interest in any general improvements was expressed in several answers. For example: "Any improved models of boilers, diesel engines, air receivers, hydraulic equipment, electrical equipment (motors)"[19] and: "always interested in any new developments"[20].

One general reply, that is to say referring to all mechanical plant, made three suggestions: (1) centralised powered lubrication to replace individual greasing points; (2) better and more robust guarding of danger areas: and (3) streamlining to remove pockets for the accumulation of dirt, etc[21]. Centralised powered lubrication is available and has definite advantages but it is not always the best answer to lubrication problems. Guarding was mentioned in other replies and will be treated later. Elimination of pockets is particularly important in the food industry and has been stressed in booklets issued by the British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead.

Boilers

One demand was for "overall improvement"[21], an aim which will be shared by all users and manufacturers of boiler plant, indeed of most categories of plant; and if we go on demanding it and stating our wants rather more specifically we should be making our contribution towards the inevitable improvement.

An implied criticism (probably justified) of oil-burning control equipment was included in a request. The correspondent asked for an oil burner which incorporated failure-to-safety devices as normally fitted but eliminating the tendency of the safety features themselves to become the cause of failure and excessive maintenance[22]. There is a responsibility on the user to seek and heed specialist advice. Adequate equipment does exist but the oil must also be satisfactory and the burner and control devices appropriate.

A user with an unusual problem asked for a compact boiler, economical in operation, capable of providing steam for curing concrete products[24]. The emphasis was on the compactness, but it is not known whether the small size was to render it suitable for a fixed installation in a small shop or merely for portability and general convenience in site work.

At least one inquirer was searching for a boiler feedwater treatment which did not involve the use of chemical additives[23]. It is a hope with a hint of alchemy, but certain manufacturers may have the answer.

Diesel Engines

When reduction of vibration is the requirement it is a matter of degree. Diesel engine design continuously improves and the vibration and noise from high-speed engines has been substantially reduced. No doubt there will be further development along these lines. Much can be

done to reduce the nuisance by sound insulation and anti-vibration mountings. It is clear, however, that not all users are satisfied with the present state of development in this field[26].

A recommendation worth quoting referred to all types of engines. It was that they should carry tally plates showing the recommended oils for particular applications. "Handbooks get lost so easily"[27].

Compressors

The commonest complaint with compressors, apparently, is also noise and vibration[28, 29, 30]. Another common trouble is the condition of the compressed air. It is not sufficiently moisture free[31] nor oil free[32].

In answer to these fairly typical criticisms it should be pointed out that reasonably quiet compressors have been on the market for some years up to capacities of about 100 cu. ft per min. Developments with filters and separators are still taking place. A specific requirement for oil-free compressed air was where it was used for water agitation in rinse baths after electroplating[33].

A particularly interesting request was for a centrifugal compressor or a non-lubricated sliding vane rotary compressor for steam, capable of increasing the pressure by 5 lb per sq. in. The inlet volume was stated as 50 to 2,000 cu. ft per minute[34]. Perhaps there are more applications for equipment of this kind than is generally realised.

One reply stated that constant trouble was experienced with grease guns and pumps operated by compressed air for the servicing of motor vehicles[35]. This sounds like bad luck or bad equipment. The manufacturer of the equipment should look to his laurels and the user should have a good look round the Engineering Exhibition at Olympia.

It seems that some compressors have too many external components which are liable to damage.[36] While it is fairly certain that this shortcoming does not apply to all compressors made in this country, it is obviously desirable to keep such components to a minimum, particularly on portable compressors.

According to one opinion the electrical gear on compressors is not of a standard comparable with the rest of the equipment[37]. In some instances this complaint may arise due to the wrong type of equipment being used for the application concerned. Sometimes mechanical unloading gear is to be preferred to electrical control gear, for example where frequent cutting in and out would impose too heavy a duty on contacts. But in a highly competitive market it must be very tempting for compressor manufacturers to cut their prices by including poor electrical gear—but compressors are not unique in this respect.

Pumps

There are so many types of pump and so many pump manufacturers that it was not to be expected that there would be many unsolved problems under this head. In fact one comment was that it had always been possible to purchase suitable plant for the particular applications involved[38].

One user expressed an interest in petrol pumps and accessories[39]; another in hydraulic pumps for lift trucks;[40] yet another wanted pumps to handle acidulated lead oxide sludge[41]. This duty is perhaps typical of the more severe pumping problems where corrosion is combined with handling sludges or liquids with considerable solid content.

For special duties it sometimes happens that a foreign manufacturer has succeeded where British manufacturers have failed. At the present time the writer is looking for a pump made in this country to replace a Continental make.[42] It has been claimed that the foreign pump is the only one capable of standing up to the duty, although, in fact, it has cost a great deal in maintenance. It is a seven-stage turbine centrifugal pump pumping fatty acids at 300° F. Very frequent attention is needed, particularly to the gland.

One method of overcoming gland leakage where objectionable chemicals are involved is to use a self-priming pump with the gland on the suction side, positioning the pump so as to maintain a negative head on the suction side. The self-priming feature, is, of course, to overcome the difficulty of having the pump above the level of the liquid being pumped. At the same time it avoids any troubles which might otherwise arise due to in-leakage of air through the gland. If the problem is expensive enough this solution might be warranted.

Gearboxes and Transmissions

Under the heading Gearboxes and Transmissions reference was made by several users to the fact that Britain appeared to be lagging behind some other countries (mention was made of the United States specifically) in the development of power shift transmission, hydraulic torque converters and the like[43, 44]. A more competitive selection of gears was demanded. Others supported this view by asking for items which might reasonably be expected to be readily available, for example: (1) a standardised range of oil filled right-angle 1-to-1 gearboxes, either of the bevel or helical gear type[45]; (2) a low-cost gearbox to transmit a maximum of ¼ horsepower, having a range of four speeds with a unity ratio maximum—output speed range to be approximately 4 to 1[46]; (3) small gearboxes (20 to 1)[47]; and (4) powder type clutches (in this case an overload release was also asked for)[48]. On the other hand, one company claimed to have been able always to purchase suitable plant for their particular needs[49].

Shorter delivery times for ¼ hp and single reduction gearboxes were suggested[50], and one correspondent thought it reasonable to expect ex-stock delivery of "gearboxes, etc"[51]. The greater the range, of course, the less would be the chance of ex-stock delivery. Certain lines no doubt are obtainable ex-stock. Perhaps manufacturers could increase the number. It is for them to judge. They will know the demand better than the individual user and they will know how much increased stocks will increase their costs and selling prices.

One requirement must be recorded in detail. It was for a multi-stage selective gearbox in *one* unit with up to 64 progressive ratios. This gearbox would be used for building into electric-cable manufacturing machinery for selecting a variety of draw-through speeds. It would have to be a floor-type box with horizontal input and output shafts[52].

Production equipment, but of a more familiar kind prompted a further comment on choice of ratios. The correspondent referred to the geared heads of lathes and drilling machines and complained that standard machines, with very few exceptions, had a wide speed range, so that for heads with up to 12 speed changes the mean geometric progression was high. In practice the geometric speed progression was unequal and the position deteriorated from the production angle because economical machining speeds often could not be maintained. The problem is explained in greater detail under machine tools and solutions suggested[53].

Another user wanted gearboxes with joints, seals and caps that were "*really* oil-tight"[54].

Hydraulic Equipment

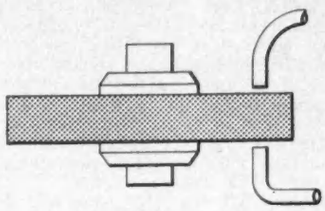
Under the heading Other Mechanical Handling Plant treated later in this article, reference is made to a request for a fork lift truck having a hydraulic stop valve to limit the lift when working in limited headroom[55]. The nature of the valve and the method of automatically operating it when a given limit is reached would vary according to the solution put forward. Probably the specialist in hydraulic equipment will be able to offer an answer.

There was at least one satisfied customer who stated that he had always been able to purchase suitable plant for his particular needs[56]. On the other hand, another opinion was: "It would appear that there is nowhere near the selection of hydraulic equipment in this country that there is in America, and if work goes to America then the price is wrong by the time it reaches this country"[57].

General criticisms of hydraulic equipment either direct or implied were as follows: (1) greater attention to simplification to facilitate price reduction[58]; (2) for an injection moulding machine, a seal to last the life of the machine[59]; (3) stronger casings for hydraulic pumps[60] (it is to be hoped that this user does not feel the same way after having tried *every* British make available); (4) quality improvements in hydraulics and surface finish, etc.[61]; (5) hydraulic valves to give the correct oil flow with a minimum back pressure (presumably this requirement calls for near streamline flow through metering valves at all flow rates)[62].

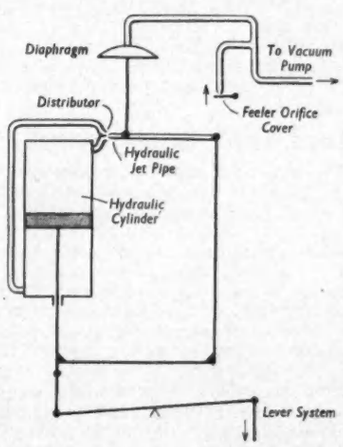
A very general request was for "any new developments in hydraulic equipment which could be applied to our machine-tool building programme"[63].

It will be interesting to see the reaction of manufacturers to the apparently eminently sensible suggestion that hydraulic surface grinders should have a built-in coolant feed on to the wheel as illustrated in the sketch below, instead



of an outside pipe feed nozzle[64]. There would also appear to be no difficulty in supplying a "hydraulic assembly and riveting press for stator and rotor packs of fractional horsepower electric motors, preferably with a 'skewing' device for rotors"[65]. One requirement will mean more to the specialist in hydraulic machinery or diesel engines than it does to the writer. Accordingly it is quoted verbatim: "Hydraulic conversion set—steam shunting loco to diesel"[66]. Presumably the correspondent is referring to a diesel engine with fluid transmission as a replacement for a steam engine.

There was another implied criticism in one user's request for a piece of hydraulic equipment which is apparently available in Western Germany but not in this country. The description was rather lengthy and in order to help readers to appreciate what is involved the writer gives a sketch showing what he understands from the



description. The equipment is a small self-contained hydraulic control unit comprising a hydraulic pump with motor drive, a jet pipe system with a distributor for actuating a hydraulic cylinder, a diaphragm for controlling the movement of the jet pipe and a vertically mounted

hydraulic cylinder. The unit is required to operate a lever system which is coupled to the connecting rod. The air-operated control diaphragm receives a differential pressure created by a feeler orifice in a vacuum circuit obtained by a small pump giving approximately a 10 in water gauge vacuum. The covering and uncovering of the feeler orifice causes the cylinder to move in the appropriate direction. The feeler orifice may for example be operated by temperature (the arrow in the diagram shows direction of movement for a rise in temperature); and the lever system might operate, say, a steam valve (arrow shows direction of movement for valve closing). The piston is required to move 6 in in 4 seconds with a maximum force of 220 lb[67]

The last contributor to this section thought that a range of small standard cylinders with inbuilt snubbing arrangements *not* involving packings would be valuable[68].

Pneumatic Equipment

It seems that the production policies of manufacturers of pneumatic equipment are questioned by some users. One asked for an extension in the range of miniature fittings[69]: another deplored the tendency for certain companies to discontinue production of particular "lines" and spares, forcing customers to accept new and not always better "lines"[70]. This criticism is not confined to pneumatic equipment. A third user requested more standardisation between the various manufacturers of pneumatic equipment[71]. His request was also echoed by users of plant in several other categories.

Three suggested developments are worthy of note. One called for the development of small compressed air motors, suitable for replacing electric motors[73]. It may well be that there are situations calling for such a replacement; but they may not be sufficiently numerous to warrant a great deal being spent on this development. Compressed air is an expensive service. The second suggestion referred to small pneumatic presses and asked for a built-in safety device to obviate the need for outside guards which tended to obstruct operation[73]. Even if built-in, most press guards must tend to obstruct operation; but no doubt there is room for improvement in some cases. In the third suggestion, the user asked for a half-ton pneumatic hoist to traverse pneumatically and inch along a 60 ft run of rolled steel joist with the same facility as in gear for hoisting pneumatically and inching[74].

In connection with pneumatic timer circuits there was one demand for a reliable and sensitive unloader valve[75]. Unfortunately reliability and sensitivity do not always go together.

Somebody interested in another field, namely pneumatic riveting, recommended improvements in offset guns to maintain maximum efficiency in obstructed positions. Apparently his experience was that cranked snaps had a tendency to form rivet heads offset from the body of the rivets[76].

Electrical Equipment

The section on Electrical Equipment proved very popular. For the sake of brevity the following requirements are merely listed: more robust and reliable portable electric tools, grinders and scrapers able to stand up to hard work[77]; simple, cheap inkless recording wattmeter or ammeter for recording actual working time of machinery[78]; better deliveries especially for overseas equipment on special voltages[79]; contactors almost silent in operation[80]; longer life for switchgear contactor points[81]; standardisation on spindle diameters and lengths for electric motors[82] (surely a great deal has been done already in this direction); a more robust shock-resisting type of microswitch[83] (we should all like this); better push button starters[84]; speed controller of low price for fractional horse-power alternating-current motors[85]; a better supply of heavy-current air-break contactors[86]; and infinitely variable electrical speed control of ac conveyor drives comparable in price to gearboxes[87].

In some cases—the last mentioned above, for instance—the user may appear to be asking for the moon. On the other hand, some requests appear to be for equipment which is already available. In the writer's experience heavy-current air-break contactors are readily available. But this depends on what is meant by "heavy current." Push button starters are another example. Good ones are available—at a higher price, of course.

As has been mentioned before, poor quality electrical gear is too often supplied on machines in order to reduce the price. Another reason may be that the person specifying the gear is not an electrical engineer and may not be qualified to select the most appropriate type or quality. One user wrote as follows: "As a company we prefer to specify basic designs and essential equipment for special machines, but are of the opinion that units, electromechanical, to carry out drilling, tapping and machining operations leave much to be desired. Small, compact, self-operating units are (1) not obtainable, or (2) badly constructed. The vendor invariably offers equipment which is totally unsuitable"[88].

Many other subjects were mentioned, the following being examples: 3 kVA alternators to be mounted on road vehicles and driven by power take-off[89]; a fractional horse-power *silent* variable speed (3-to-1) geared motor unit with an output speed of about 150 rpm[90]; more care should be taken to protect electrical gear from the effects of oil and coolant fluids[91]; any new developments which could be applied to a machine-tool building programme[92]; provision for pressing out and replacing electric motor armature shafts (in many cases damaged splines or keyways involve the purchase of a complete armature)[93]; a simplified form of crane control gear which will eliminate large banks of resistances and large contactor panels associated with present day equipment on high capacity cranes[94]; better smoothing on direct-current output control from small low-voltage rectifier units—also constant amperage control[95]; improvement in the life of electric-furnace heating elements[96].

A recommendation which might be singled out for comment was that there should be more standardisation and use of plugs, thus enabling non-skilled movement of machines[97]. Several points should be made.

(1) Agreement to more standardisation: much has been done to improve matters but there is still room for improvement.

(2) The connection of electrical equipment by Tom, Dick and Harry is something to be discouraged rather than encouraged. Nevertheless in certain situations it could be right and proper and worth while to make it easy (with good fittings, properly maintained) for the non-electrical employee to move machines from station to station.

(3) The British Standards Institution have gone a long way towards a satisfactory solution with their standard 13 amp plugs. With their 2, 5, 10 and 13 amp fuses, and used in conjunction with the ring-main technique, these plugs represent a substantial step towards rational standardisation. Here again the equipment is liable to misuse by the ignorant.

Can any manufacturer help the user who wanted an electric furnace for melting non-ferrous metals for the production of castings at a price competitive with oil, gas or solid fuel furnaces, taking into account both capital costs and running costs? The furnace should be capable of rapid changes of alloy, otherwise it would not compete on versatility[98]. There may be much to be said in favour of electric furnaces; and in certain fields they may be the only solution; but the only way in which they can compete with other types in running costs (at least as far as fuel costs are concerned) is by the use of power generated by back-pressure steam plant. Indeed one of the most important improvements that can be asked for in the electrical field is the much more extensive use of back-pressure plant to generate electricity. Unfortunately, however, the electricity authorities seem to regard this development as not within the province of the electrical engineer.

Thinking in terms of modern developments and trends, a research manager wrote that in electrical equipment greater use should be made of new electrical materials now available to minimise the size of the plant[99]. The type of plant was not stated.

As a fitting footnote to this section the following suggestion is quoted verbatim: "Neatness, practicability of installation; adequate simple wiring instructions and diagrams for assistance of maintenance staff. Ample access for wiring; simple replacement of mechanisms subject to wear without special tools, fittings or necessity to remove whole unit or casing; cost less important than efficiency in view of loss on shutdown time"[100]. This is something of an indictment. Is it justified?

Conveyors

The first contributor under the heading Conveyors wrote: "We are at present interested in a conveyor either of the roller or the suspended type which will act as a mobile store, but at the same time will not be circulating continually as normal conveyors do. We have only been able to find one recently introduced conveyor of the roller type and, as yet, none of the suspended type of conveyor which meets this requirement. It is a prerequisite that the equipment should be reasonably priced"[101]. The writer confesses that he is not quite clear on this requirement. However, it is hoped that conveyor specialists will recognise the problem.

Another type of conveyor mentioned was one suitable for handling asbestos fibre. Surely there must be a standard type of machine which would be suitable[102].

Yet another kind of conveyor asked for was an inexpensive design to carry very light component parts not exceeding 3 lb but mostly in the region of 8 oz. The overhead conveyor which was intended for use in flow production to carry parts from one assembly point to another should include inexpensive means of tripping and homing[103]. Surely there is on the market equipment to fill this need. Perhaps the operative word is "inexpensive" which could mean anything.

Then again a user referred to effective tube or pipe conveying of sand[104]. A lot depends on exact requirements. Sand is an unkind material from a maintenance point of view and probably there are practical limitations both with pumping sand or pneumatically conveying it. The manufacturer would probably want to know more about this inquiry; and possibly some development work would be necessary. Practical knowledge of pneumatic conveying appears to be sparse.

There were two more specific conveyor requirements, one for mesh conveyor belts to operate at a temperature up to 1,150° C[105] (bearing in mind both the life and the cost) and the other for a conveyor suitable for phosphating plants. Here the plea was for the complete enclosure of all ball races and moving parts[106]. At present it seems they are useless under the conditions prevailing.

Finally there was a general request for standardisation leading to reduced costs[107].

Other Mechanical Handling Plant

The section on Mechanical Handling was chiefly noteworthy for its variety. Two users referred to fork-lift trucks; but the other subjects mentioned were entirely unrelated to one another.

One humourist (if he will forgive the epithet—as I fear he may have been quite serious) was looking for fork-lift trucks at about half the present price[108]. This is one requirement on which we can be quite categorical. At the present time there are no such trucks on the market.

The other user interested in fork-lift trucks wanted one incorporating a hydraulic stop valve to limit the lift when working in limited

headroom. The application was for the loading and unloading of annealing ovens. If a manufacturer could supply the necessary hydraulic equipment this user was prepared to carry out the necessary modification. He required the equipment in any case for the modification of existing trucks[109]. Perhaps this should have been mentioned also in the section on electrical equipment.

A request which on the face of it sounded somewhat extraordinary was for any machine which would mechanise sheet-metal operations. It gave the impression that automation was involved and that transfer machines were in mind. This illusion however appeared to be dispelled by the words in brackets "(no bulk production)"[110]. Here surely is scope for the manufacturer of sheet-metal machine tools. No doubt we need more of them in this country. Perhaps this user had in mind machines which would assist the development and marking out operations for relatively straightforward operations. In this case we are under the wrong heading.

Another case, perhaps also under the wrong heading, referred to automatic feeding devices for high-speed mechanical presses for short job lot production. The requirement was for an extremely short set-up time from automatic to non-automatic production and vice versa[111].

Yet another handling problem relating to machine tools asked for more consideration to be given to the more widespread incorporation of integral materials handling equipment (for example, cranes) on large machine tools[112].

Finally, from the user who made the same comment regarding compressors, there was a plea for "fewer external components liable to damage"[113].

Welding Equipment

Replies on Welding Equipment were consistently straightforward, sensible and varied. Some contributors should be able to find what they want already available. Typical of those which were very brief and to the point were: (1) any improvements in welding aluminium (or was it any improvements *on* welding aluminium?)[114]; (2) a plug socket for a portable light fitted to a portable welding plant[115]; (3) a really effective continuous wire-feed hand welding gun[116]; (4) an ammeter on the output side of a welding plant[117]; (5) a built-in power-factor corrector for a welding transformer (200 to 300 amp oil immersed)[118]; (6) welding equipment for use on galvanised tube with simple and mobile fume extractor[119]; (7) an electrode for welding 70/30 brass to mild steel[120]; (8) good copper welds[121]; and (9) welding equipment for the argon-arc welding of light stainless-steel components (light gauge tubes and delicate attachments)[122].

The following four examples were critical of existing equipment: (1) argon arc—"we should prefer to have a less cumbersome design hood for this plant, as this would facilitate its operation—we think that the present hood consisting as it does of a jumble of tubes, is unsatisfactory"[123]; (2) a spot welding machine capable of producing a weld without marking on one exterior face (20 swg × 2 cold-reduced general-purpose mild-steel sheet)[124]; (3) highly efficient copper tips that would not pick up aluminium and would not require frequent cleaning[125]; and (4) British-made equipment similar to American Stoges but more accurately and robustly designed and yet not so expensive as American Doall. "We have to recommend American machines to our customers"[126].

One user, concerned with small resistance welding machines asked for an inexpensive and reliable current and time controller for fitting to existing machines[127]. Another asked for "resistance welding equipment (spot-welding) for medium and small sheet metal work—portable type, possibly powered from existing static equipment"[128]. Another correspondent required flash butt welding equipment for jointing rectangular tubes $\frac{1}{16}$ in thick, which after welding would be completely free of pin-holes[129].

An ingenious suggestion was put forward in connection with electrode holder flexible cables. It was a ball socket (sleeved) for entry of the power cable to protect the flexible cable from being repeatedly bent during welding operations, with consequent damage to the cable covering[130].

In a rather different field, namely, machine flame cutting, there was a request for an attachment for the automatic adjustment to height of the nozzle, to allow for unevenness in the plate. It was thought that there was such an arrangement on a new, large and expensive machine which was thought to incorporate mill scale clearance in addition.[131]

While on the subject of automatic equipment another user thought that there was a need for a semi-automatic welding unit possessing a foolproof feeding arrangement designed to reduce operator fatigue[132].

The last case to be mentioned also refers to self-feeding; but the material to be welded was thermoplastic. The need was for "a self-feeding high frequency welding machine for thermoplastic materials"[133].

Testing Equipment

As might have been expected, Testing Equipment covered a wide range; but unfortunately there were not many users who commented under this heading.

One asked for a method of casting inspection for internal defects other than X-ray methods[134]. There are other devices on the market but not necessarily to suit this particular user. On the same subject another user asked for improved non-destructive testing[135].

A completely different problem is the testing of the life expectancy of fluorescent tubes. A user suggested that the equipment at present in use could be improved to enable life tests to be made more quickly[136].

On a different subject again there was a request for a reasonably priced means of testing the thickness of electroplating deposits on steel[137]; although it must be admitted that such an instrument could conceivably be related to one for detecting casting defects.

On a more down-to-earth level though hardly commonplace was a demand for a compression testing machine at a reasonable price up to 250 tons capacity with "daylight" of approximately 3 ft and component diameter up to 22 in[138].

A contributor asked for testing equipment of smaller bulk but did not specify what sort of testing equipment[139]. However, he is probably right for most kinds; so, will manufacturers of testing equipment please note!

The writer wishes to make a quick survey of cast iron water mains in order to find the wall thicknesses. An ultrasonic thickness tester has proved totally unreliable for this purpose. If there should be a suitable instrument on the market for this application there would be many other possible uses for it which would warrant considerable expenditure[140].

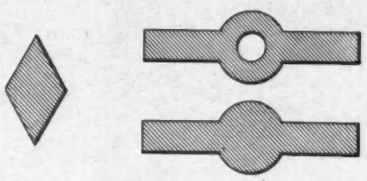
It is not unreasonable to include in this section an inquiry for counting equipment for mass produced components at the finished packing stage[141]. More than one manufacturer will have something to offer here.

Machine Tools

It will be noted that the 12 categories which were the subject of the questionnaire excluded metalworking machinery. The intention was to concentrate attention on these categories. Nevertheless, the question "Is your company looking for a new machine or item of equipment to perform a particular job or function?" gave scope for reference to machine tools or indeed any other type of equipment outside the 12 specified.

There were in fact so many contributions under this heading (by far the majority being machine tools) that space will not permit more than a bare mention of them. It would be a pity not to take full advantage of this opportunity of bringing to the notice of manufacturers the needs of their customers. As far as possible, therefore, the replies are quoted below, machine tools and other production equipment being treated first.

(1) A machine for twisting diamond section and turbine section steel, solid and hollow as



shown, in 20 ft lengths, into a spiral shape, varying from $1\frac{1}{4}$ to $2\frac{1}{2}$ in across the web[142].

(2) Machine for grinding and polishing large turbine blades up to 3 ft long, of complicated shape[143].

(3) Machine for drilling, milling and tapping small forgings without resetting (mechanical, hydraulic, pneumatic)[144].

(4) Machine to cut Imlok extruded sections as manufactured by Alfred Imhof Limited[145].

(5) Automatic equipment for winding solder wire on reels, preferably of a type which winds a specific weight or length on to a reel and stops automatically, whereby one operative could attend to three winding heads[146].

(6) "We do not use any of the above equipment [the 12 categories]; our plant consists of automatic lathes, capstan lathes, millers, drillers, etc. As regards improvement, these machines have reached a high stage of development already but there is a growing practice among manufacturers of machine tools to supply their products in the simplest possible form, omitting items which to most users are virtually essential. These items are then called 'attachments'; and exorbitant prices are charged for them. Surely if these parts were made and marketed in unit with the rest of the machine the cost would be reduced and the benefit to the users would be obvious. Examples of these 'attachments' are the drilling and threading spindles on Swiss type autos and the slotters on all autos"[147].

(7) "We should be glad to know if a straightening or flattening machine exists which is suitable for straightening and flattening small distortions in metal discs which result after pressing these discs from raw material. The discs vary from about 2 in diameter up to about $10\frac{1}{2}$ in diameter. The thickness varies from $\frac{1}{32}$ to $\frac{1}{8}$ in in common gauges. The materials are mild steel, stainless steel and bronze"[148].

(8) Gravity die casting machines. Small cutting-off machines suitable for removing runners and risers on gravity die castings[149].

(9) A press brake[150].

(10) "We have been looking for several years for a new cutting material of the tungsten carbide or ceramic type, which is better than those current on the market, so that heavier feeds and higher speeds can be taken in turning large and bulky pieces of steel and hard cast iron. There is also room for an improved type of high-speed steel to give an even greater performance than the best cobalt chrome types current on the market. Present modern machine tools are quite capable of using this efficiently without mechanical modification or increasing the horsepower at present driving the machines"[151].

(11) Metal powder grinding to very small flake-type particles (less than 10 microns, say) plus some form of final sizing separator[152].

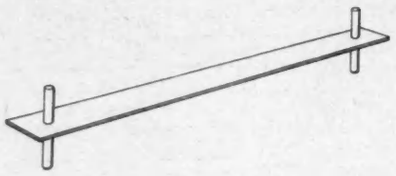
(12) A smaller machine than the standard machines available for the extrusion of soft metals in wire form[153].

(13) Machinery for the preparation of plate edges prior to welding which will speed up the operation and reduce the handling costs of placing large plates in plate edge planers or shears[154].

(14) A method of producing crane gearing, particularly large gears, to BS Class B standards which will reduce the high costs of material and machining[155].

(15) A press and feed complete with tooling

to produce a 6 in length of strip ¼ in by 0·014 in from coil strips to be pinned each end with wire 0·064 in, the small slugs of wire being used as the punch and left *in situ* as indicated in the sketch below[156].



(16) A metal saw (circular) to cut dry[157].

(17) A machine to carry out the automatic machining of scaffolding fitting components and the assembly of same[158].

(18) "We are looking for a complete spraying and stove enamelling plant at a low price"[159].

(19) "There is only one British manufacturer of spring coiling machines. Many British firms buy German. We prefer German machines for all but a certain few coiling jobs. A pity"[160].

(20) Metal spraying equipment capable of despositing a non-porous coat[161].

(21) A small template following machine for producing metal tabs, lockwashers, gaskets in one-off, in thin copper, steel, stainless, etc[162].

(22) Shipyard bending rolls. Rolls should have, in addition to bending and flanging facilities, a device enabling the machine to be used for levelling ships' plates. Such a machine would be a great boon to the ship repairing industry where at present a firm must invest in two very large and expensive machine tools, one for bending and flanging and one for levelling plates[163].

(23) An automatic nut making and tapping machine for ¼ in, $\frac{5}{16}$ in and ⅜ in nuts, or alternatively, an automatic nut tapping machine only[164].

(24) A two-spindle bench type drill, motorised, 1⅛ in capacity[165].

(25) "As the manufacture of small electrical fuses is highly specialised, we have become accustomed to either adapting existing types of plant or building our own equipment"[166].

(26) "We make the majority of our own machine tools for our own specialised use" (twist drills)[167].

(27) "We have seen hand-operated shears (about 30 in handles) with a geared cut at the blade pivot point. They will cut ¼ in plate. They were seen on the Swiss-French border but were unknown in Basle, Berne, Zurich and Geneva. Interesting"[168].

(28) A machine for the accurate rounding up of 16 gauge stainless-steel *welded* cylinders 30 in in diameter by 6 ft long to within $\frac{1}{32}$ in concentricity[169].

(29) A double mitre saw for aluminium extrusions[170].

(30) A simple machine at reasonable cost for chamfering the ends of bar material at both ends simultaneously and alternatively at one end only. Not a precision machine and suitable for black bar (sawn or sheared ends)[171].

(31) A machine for corrugating steel sheets[172].

(32) Angle bending machines[173].

(33) A machine for producing spirally wound metal strip, such as is used for flexible shaft casings[174].

(34) A 50 to 80 ton power press with precision roll-feed for electrical lamination sheet strip, having an automatic cropping device to trim both ends of each strip—similar to "Schuter" and suitable for "follow-on tools"[175].

(35) De-burring machine for electrical lamination pressings, such as "Micafil"[176].

(36) Precision worm-milling machine for steel worm gears, 12 to 50 diametral pitch—such as "Mikron"—designed for use with disc type cutters[177].

(37) Small-hole honing machine for holes of from $\frac{3}{16}$ in to ½ in diameter and from 1 to 2 in long[178].

(38) Second-operation type lathe with short bed (tail-stock not needed) having robust compound slide rest and fitted with internal expanding mandrel—range $1\frac{3}{16}$ to $3\frac{1}{8}$ in diameter—to grip hollow components (weight up to 15 lb) while facing and turning spigots or internal register diameters[179].

(39) Redesign old-style machine tools to give streamlined and modern appearance[180].

(40) The addition of reversal arrangement on the spindle rotation of honing machines[181].

(41) "As a company, we prefer to specify basic designs and essential equipment for special machines, but are of the opinion that electro-mechanical units to carry out drilling, tapping and machining operations leave much to be desired"[182].

(42) A Desoutter (or similar type) Rackfeed Drill to take up to 1½ in drill[183].

(43) Machine to flatten thin strip reliably[184].

(44) "Geared heads. We are mainly concerned with those on lathes and drilling machines. Generally speaking, they have 6, 9, 12 and 18 lever operated speed changes. As mentioned under the heading Gearboxes and Transmissions, on heads with up to 12 speed changes, the geometric speed progression is large and unequal and economical machining speeds often cannot be maintained."

An example is given: "Our basic machining speed for cast iron would be 300 ft per minute using tungsten carbide tools. For machining a 6 in diameter workpiece the planning engineer would calculate a speed of 190 rpm. The planner then selects the machine for the job and when he checks for the nearest speed he finds that 130 and 210 rpm are available. A geometric progression of 1·62 in such a case is quite commonplace—on a lathe, for instance, having a 12 speed head. If he chooses 210 rpm he exceeds the permissible 300 ft per minute by 10½ per cent; if, on the other hand, he selects 130 rpm, he is 31·5 per cent below the desired speed. Neither method is satisfactory.

"Thus close ratios in a gearbox would have decided advantages where maximum production speeds are needed for 'near' repetition work. This close ratio, however, cannot at present be given. On ferrous and non-ferrous components production requirements can be very varied. Furthermore, cutting speed varies according to the cutting tool material, HSS or tungsten carbide. The result is that manufacturers offer light, medium and heavy duty machines. The light machine would have a much higher speed range than the heavy one, and also offer some variation in sturdiness. The speed range of geared heads can usually be varied by changing the motor speed or the driving pulleys from the motor; otherwise it is necessary to accept the speed range and gear ratios within the geared head.

"Suggestions: For general work a wide range of speed is required so that wide geometric progression between the speeds is inevitable. For customers who need a machine for limited use the manufacturers could design a 'close ratio' gearbox having something like 1·2 geometric progression; conveniently placed gear selection could be provided to vary the speed range from high to low, keeping within the limits of spindle speeds arranged for the machine designed for general duties. Thus the makers could provide a machine which would have (*a*) a geared head covering a wide range of speed; and (*b*) a geared head with close ratio between speeds, the range of which could be varied by pick-off gear"[185].

Miscellaneous Plant

Many comments were made on plant not readily classified in answer to the request for additional suggestions. They are listed below roughly as they were given.

(1) Washing machines. The provision of simple and cheap washing machines which could be used in lines to sections to handle a limited range of material. "At the present time we know of only one manufacturer who deals with this particular type of application"[186].

(2) A machine to wash road tanker vehicles with oval tanks (not slab-sided) without manual aid, including the back of the vehicle. "'Washinabily' do not produce what we want"[187].

(3) Cleaning plant capable of high-speed cleaning of two-dimensionally large, third-dimensionally flimsy apparatus, of metallic and fabric construction which picks up a heavy coating of atmospheric dirt[188].

(4) Mixing machinery—some types of foundry mixers are suitable. "The type of machinery that we are looking for is covered by the chemical engineering industry"[189].

(5) Equipment costing not more than £200 for drying or otherwise removing moisture or water from the interior of 50 ft lengths of flexible tubing (corrugated bore) ½ in to 6 in diameter, quickly, easily and cheaply[190].

(6) Complete petrol tank installations and flowmeters[191].

(7) Special-purpose equipment for the orientation of papers and linens in 4 ft 0 in squares[192].

(8) Polishing equipment (it is assumed that this user refers to the polishing of steel)[193].

(9) Anything new for a research department. Nothing particularly in mind[194].

(10) "We are looking for an airless automatic abrasive blasting machine capable of economically cleaning RSJ, angles,channel and Z-sections of structural steel containing welded projections, prior to rustproofing. We can see no practical improvement in such plant over the last 20 years. We consider that research in the above is a national necessity."[195]

(11) "The nature of our product is such that we can seldom use standard machines other that in our power house and engineering department machine shops. Our requirements are covered normally by design of special-purpose machines, or the adaptation of a standard machine intended for the metalworking or other industry to our peculiar requirements. One of the main features of these adaptations is the adequate sealing of all bearings, rotating and reciprocating shafts, knuckle joints, etc. Although considerable advances have been made in this regard in recent years, we still feel that machine manufacturers have a long way to go"[196].

(12) Automatic weigh scales in sizes up to 500 lb that are capable of weighing to an accuracy of 1/400 over at least 50 per cent of their range[197].

(13) Chemical process vessels: should have built-in arrangements for lifting and slinging[198].

(14) Referring to gas controlled ovens: (*a*) decided improvement required in the electrical thermostats used to control the heat of processing ovens; and (*b*) dependable system of flame failure (especially in pipe bore over ¾ in)[199].

Distribution

Of the 12 categories of plant the one in use by the greatest number of companies replying to the questionnaire was welding equipment. Electrical equipment was about the same and the others were in the order: compressors, pneumatic equipment, hydraulic equipment, mechanical handling plant other than conveyors, pumps, gears and transmissions, test equipment, conveyors, boilers and diesel engines. As might have been expected, the degree of interest in the various categories as indicated by the replies was approximately in the same order, although the attention given to electrical equipment was considerably greater than that given to its nearest rival, welding equipment. But the interest in machine tools was obviously greater than in any of the 12 named categories.

The next issue will contain a complementary article, reporting the response of plant manufacturers to the comments made by users and quoted in this article.

It will be noted that each contribution to the survey has been numbered in the text. Manufacturers may write to Deputy Editor (Planning), ENGINEERING, quoting the relevant number and subject, so that their letters may be forwarded to the company concerned,. Alternatively, the company will be invited to approach the manufacturer. The main purpose is that manufacturers and users should benefit as a result of this experiment in communications.

Showing at the Engineering, Marine, Welding and Nuclear Energy Exhibition

Olympia, London

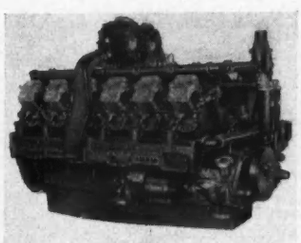
20 April to 4 May

"Something for everyone" might well be the theme song of this year's Engineering Exhibition at Olympia. Whether it be a probe for detecting the radioactive contamination of milk, a life saving raft or a 91 ton diesel engine, it will be found on one of the stands of the 500 and more exhibitors. The honorary president is Mr. A. I. Baker, who is also president of the British Engineers Association and whose stand will serve as the information centre of the show. On the same stand will be demonstrated the starting up of a nuclear power station using a reactor simulator. Components for nuclear plant feature on many of the stands. ENGINEERING'S *own stand is in the middle of the ground floor of the Grand Hall.*

The ground floor of the Empire Hall is devoted to the welding exhibits and all three halls are fully occupied, including the gallery and first floors. In these six pages, and in subsequent issues, some of the many items on display are described.

INDUSTRIAL DIESEL

685 hp at 1800 rpm



LATEST addition to the Q range of diesel engines is the 12QAT turbo-charged engine which will develop 685 hp at 1,800 rpm on the 1 hour rating.

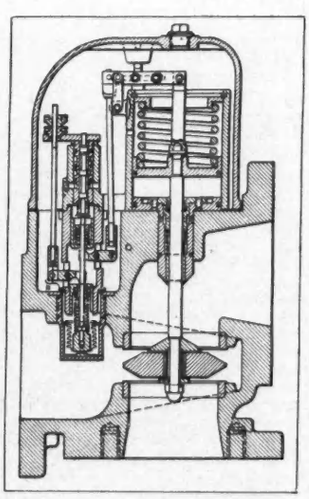
This engine is a 12 cylinder water cooled 90° V type using direct injection with a toroidal cavity piston. Bore and stroke are 6¼ in and 6½ in respectively, giving a total swept volume of 2,393 cu. in (39·2 litres). The mean piston speed at 1,800 rpm is 1,940 ft per minute.

Side-by-side connecting rods work on a common crankpin. The big ends are split at 55° to the centre line to allow the rod to be withdrawn through the cylinder bore, and the big end bearings are thin wall steel strip, lined with copper lead. The small end bush is in silicon bronze. The crankcase and cylinder unit is a rigid cast iron structure extending below the crankshaft centre-line. The main bearing caps are under-slung. Chrome hardened detachable wet cylinder liners are employed, centrifugally cast in iron. The crankshaft is an alloy stamping with induction hardened pins and journals. Main bearings are thin wall steel strip copper-lead lined.

Separate heads are used for each cylinder. Exhaust and inlet ports are fully water cooled, there being one inlet and one exhaust valve per cylinder. Prefinished valve seat inserts are used. Fuel is supplied from two 6-element Simms pumps mounted in the V of the engine and driven in tandem from the rear. The governor is on the front pump. Pressure lubrication is employed for all main bearings. The turbo-chargers are mounted on the inlet manifolds. *W. H. Dorman and Company Limited, Stafford.*

THERMOSTAT

Coolant Temperature Control



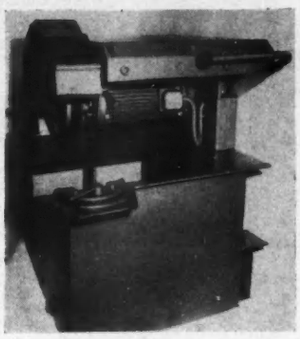
PRECISION control of the temperature of the engine coolant can be obtained by the thermostat illustrated.

This has a seated control valve of self aligning design, which keeps leakage to a minimum. Other features include servo operation for precise and fast action; and robust construction to stand up to arduous conditions as encountered in traction applications. The seated type of valve also gives the quickest warm up of the coolant, reducing the cold time during which wear is most pronounced. Corrosion resistant construction of the unit makes for low maintenance costs and the operation is unaffected by the water pressure or flow rate. The spindle gland is self adjusting.

The capacity of the 4 in model is up to 25,000 gallons per hour at 5 lb per sq. in head loss. The temperature range is adjustable from 150° F to 190° F or from 180° to 230° F and the temperature droop for full opening or closing is adjustable from 5° F to 20° F. The servo fluid is engine oil at a minimum pressure of 20 lb per sq. in with a maximum demand of 1 gallon per minute. *Ardleigh Engineering Limited, Standard Iron Works, Colchester.*

FRICTION SAW

For Ferrous and Non-Ferrous Materials



NOW AVAILABLE in this country is the Jungbluth friction saw shown in the illustration.

It is claimed that the machine will cut faster and with less waste of stock than with abrasives, and that the saw has a long life as it can be resharpened many times.

The motor is rated at 10 hp and the head is mounted on easy running bearings to give a smooth action. The saws are 20½ in diameter and will cut solids up to 1 in, channels up to 6 in, pipes up to 4 in, and I beams up to 7 in. Metal sheets can be cut up to ¼ in thick. About a thousand cuts can be made before the saw needs resharpening.

Overall dimensions of the machine are 38 in long by 42in wide by 44 in high. The weight is approximately 880 lb. The pedestal base is enclosed and the blade of the saw is fully guarded. The blades are robust and will withstand hard use. On the cutting table is mounted a work guide which can be swivelled for angular cuts and locked with a clamp. *Addison Tool Company Limited, 28 Marshalsea Road, London, SE1.*

ARC WELDER

Controlled Slope Feature

THE SIGMA model from the Miller range of welding machines can be operated both automatically and semi-automatically.

It is available in three sizes with 100 per cent duty current ratings of 300 A, 500 A and 1,000 A respectively. Very stable welding conditions are maintained regardless of arc variations, and the welds produced are described as X-ray quality.

The desired wire feed speed is set on the control and the arc voltage preset on the welder. The arc is struck and the welder then automatically provides the correct current to burn off the filler wire at the rate necessary to maintain a constant arc voltage. If the wire feed speed should momentarily increase or the arc length shorten, the current increases and vice versa.

The controlled slope feature reduces the short circuit current, eliminating arc spatter and burn back especially with small wire sizes. The 300 A model can be converted easily for tungsten inert gas or metallic arc welding, giving a current range from 3 to 400 A. *Interlas Limited, 9 Church Street, Ampthill, Bedford.*

ROTARY ACTUATORS

Torques up to 800 lb-ft

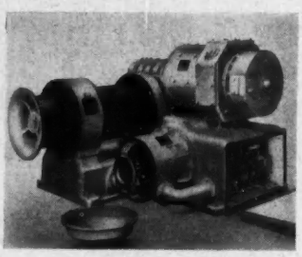
A NEW range of rotary actuators has been designed for the automatic control of valves in power stations and in process industries.

There are three sizes in the range with torques of 80 to 800 lb-ft. The rotary motion is given by a 400-440V 3 phase 50 cycle squirrel cage induction motor which drives the output nut through an oil-immersed worm reduction gearbox. The motors can also be wound for other supplies if required. The standard model is totally enclosed and weather-proof, and a flameproof version is available for dangerous situations.

A hammer blow effect for moving a sticky valve is given by an incorporated lost motion mechanism which allows the motor to run up to speed before transmitting torque to the spindle. The output nut can be of any desired form, for example, with keyed insert or acme thread, and provision is made for rising or non-rising spindles. *English Electric Company Limited, English Electric House, Strand, London, WC2.*

CARGO WINCH

For Alternating Current Supply



THE ILLUSTRATION shows the self-contained "Corrector" cargo winch for alternating current supplies.

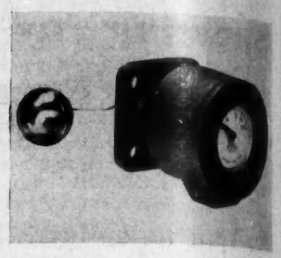
This is a high performance winch incorporating a lightweight motor-generator set supplying the motor on the Ward-Leonard variable voltage system. Claims are that the winch provides very flexible control, high rate of acceleration, and wide speed range without gear change. The performance is said to be superior to an induction regulator drive, and heavy current surges are avoided. The motor-generator and the control gear are accessible for inspection and there are no ventilators to be opened when the winch is in use.

Regenerative braking is used to control the load during lowering, and a magnetic brake will hold the load at standstill in the off position of the controller. Speed control is over a 4 to 1 ratio from light hook to full load without gear change, and on the 3 ton size the hoisting speed is 400 ft per minute with light hook. Lowering is 380 ft per minute also with a light hook. The master control pedestal may be mounted at some distance from the winch, giving true remote control. It is connected by low capacity cables.

The motor armature is the slotted drum type with the shaft hydraulically pressed into the spider. The shaft drives the worm shaft through a flanged coupling. The worm is of steel, driving a phosphor bronze rimmed wheel keyed to the shaft that carries the barrel and whipping drums. Sleeve type oil lubricated bearings are used, with a double ball thrust bearing on the wormshaft. *Laurence Scott and Electromotors Limited, Norwich.*

LEVEL GAUGE

Control for Small Tanks



THE R & G level gauge shown in the illustration is the type 1810 designed specially for fitting to small tanks.

A particular feature of the design is that the indication is not affected by swirl of the liquid and therefore the gauge is suitable for marine and traction installations. In addition to the level indication given by the pointer, there is an alarm contact that gives a warning of low level.

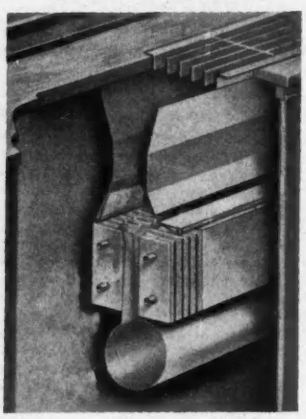
Both indication and alarm are magnetically controlled by the movement of the float arm: the pointer by magnetic attraction in order to give sensitive indication and the switch by repulsion which in turn gives a snap over and positive locking action.

The switch is the mercury tube type with both contacts at one end. It snaps through 90° at the operating point ensuring that the mercury is either in contact with the electrodes or at the other end of the tube. This arrangement avoids splash and intermittent contact. The differential between trip and recovery levels is kept as large as possible so that float arm oscillation due to surge will not cause intermittant operation of the switch. The contacts are rated at 6A 110V dc.

The front cover, which contains the dial chamber, is removable for wiring; it is 3⅜ in diameter. Since the pointer itself is a magnet it automatically picks up the correct reading when the cover is replaced. A second contact can be added to use the indicator to start and stop a transfer pump. Three models are made varying in the swing of the float and its arrangement in the tank. *Bayham Limited, 12 Lower Grosvenor Place, London, SW1.*

AIR CONDITIONER

Separate Room Units



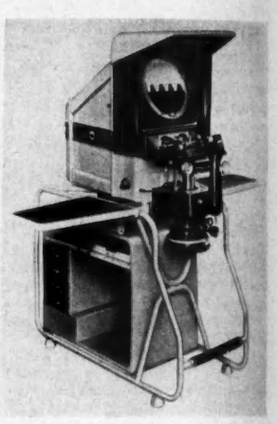
THE ILLUSTRATION shows a section of one of the separate room units of the Velovent air conditioning system.

Air is drawn into a central unit supplying the whole building and is there filtered, corrected for humidity, and heated or cooled as required. The treated air then passes along small bore pipes to the pipe at the bottom of the room unit and up through the discharge nozzles, its passage inducing a flow of room air through the heater/cooler batteries on either side. Above these batteries are tilting dampers operated from the setting control mounted on the top of the panel. The mixed air passes out into the room through the grille at the top.

These units are designed to be mounted under windows to prevent downdraughts of cold air. Each can be set to suit the taste of the occupants of the room, and heating and ventilation are supplied by the one unit. When the controls are set the conditions are maintained in spite of variations in outside weather. The response is immediate. Other than the dampers there are no moving parts and the units require little or no maintenance. The room units are made in three standard sizes with grilles of 23 in, 31 in and 47 in long. All are 4⅛ in wide. *Air Control Installations Limited, Victoria Road, Ruislip, Middlesex.*

PROFILE PROJECTOR

Vertical, Transverse and Rotary Adjustments



THE MICROTECHNICA profile projector MT/2 is provided with adjustments that allow the specimen to be moved vertically and horizontally, or rotated.

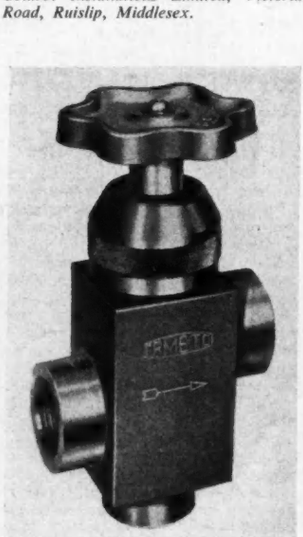
All three movements have micrometer scales for reading, the vertical and horizontal measurements being to 0·0005 in. The scanning area of the workpiece is from 0·10 in to 2 in diameter according to the magnification being used, there being a choice of 5×, 10×, 20×, 50×, or 100×. Corresponding throat clearances vary from 4 in to 1¼ in measured from the focal plane to the objective.

The table measures 14 in by 6 in and the maximum distance between centres is 9 in. The height of the centres above the table is 1¼ in. The table can be rotated 15° either way, the scale reading to 5 minutes. Vertical and horizontal movements are 4¼ in and 3¼ in respectively.

The rectangular screen has a viewing area of 11¼ in by 13¾ in, and the adjustable rotating screen which can also be used is 9¾ in diameter. Projection can be either diascopic or episcopic. The lamp is rated at 50 watts on 6 volts and the supply can be from 110 to 280 volts 50-60 cycles. A revolving lamp holder permits the inspection of the table. *Headland Gauges Limited, 45-46 Lower Marsh, London, SE1.*

STOP VALVE

Pressures up to 8,000 lb per sq. in



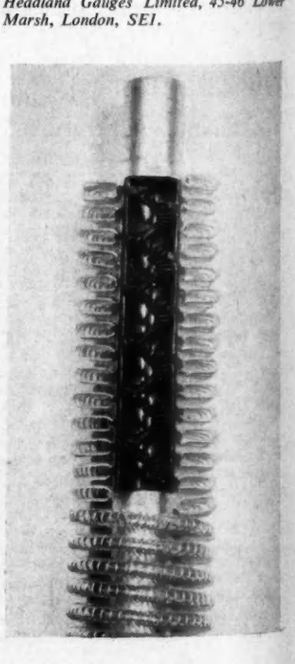
A RECENT addition to the Ermeto range of valves is the type 509, one version of which is illustrated, designed for high pressures.

It is a stop valve with balanced pressure for easy operation. There are four sizes from 1 in BSP to 1¼ in BSP with maximum working pressures from 8,000 lb per sq. in to 5,000 lb per sq. in for fluids, and from 5,000 lb per sq. in to 2,500 lb per sq. in for gases. The valves can be supplied in mild steel, high duty bronze or stainless steel.

The spindle is made from stainless steel in all versions and has the operating threads external to the medium. Both spindle and sleeve sealing is effected by synthetic rubber O rings. Plastic handwheels are fitted to the bronze models and bronze wheels to other types. Balanced valves can be supplied with unequal ends or with special ends integrated with the body. Other ranges of stop valves are available with male ends, and for nominal bore sizes down to ¼ in. BSP., differing slightly in construction from the type illustrated. None is suitable for use with steam. *British Ermeto Corporation Limited, Beacon Works, Hargrave Road, Maidenhead, Berkshire.*

HEAT EXCHANGE TUBE

Extended Surface



THE illustration shows an example of the Clayton-Still heat exchange tube designed especially for oil or liquid hydrocarbons.

The extended surfaces consist of a continuous wire wound into elongated loops which are firmly bonded to the basic tube in a helical formation. For cooling oil or other liquid hydrocarbons the inner surface is extended either by the insertion of three small diameter tubes (generally for cases where there is suspended matter) or by a spiral looped wire formation as shown. The latter is available without a centre rod so that it can be used in applications where the rate of heat exchange and the fluid pressure drop are critical.

No standard sizes are made and varied demands can be met by simple alterations to surface ratios. Wound tubes with basic diameters of ½ in to 3 in and over wire diameters of ⅛ in to 4½ in can be supplied in 25 ft lengths in most materials. *Clayton Dewandre Company Limited, Titanic Works, Lincoln.*

FLAME PLANER

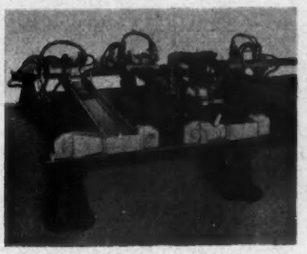
Four Sides of a Plate Simultaneously

A LIGHTWEIGHT flame planer is now available which will cut all four sides of a plate simultaneously.

The machine is a specially designed and simplified version of the Hancoplane and is made up of many standard components used in the other machines made by the firm. It will give all the usual types of material preparation that are required before welding. It is claimed that it is substantially less costly than other machines of similar capacity and performance.

The maximum width of steel plate that can be handled by the planer is 12 ft and the standard length is 30 ft; this, however, can be increased as desired by the addition of extension rails. The machine is also designed for contour cutting which has particular application in the shipbuilding industry.

The three gantries carrying the cutting heads run on precision ground rails, and the main gantry which makes the longitudinal cuts simultaneously is propelled by a variable speed motor.



Mounted on the gantry are two carriages carrying the compound cutting heads, which are fitted with a graduated tape to enable them to be set to cut a plate of any given width. This eliminates the necessity for marking out. The heads can also be adapted for carrying out contour cutting.

The gantries for making the end cuts carry variable speed motorised tractor units each fitted with a compound burner head for transverse cuts. Controls are centralised and the burners are controlled by switches operating solenoid valves. *Hancock and Company (Engineers) Limited, Progress Way, Croydon, Surrey.*

ADHESION TESTER

For Bearing Linings

THE QUALITY of the bond between the backing and the lining of a bearing can be checked non-destructively by an instrument recently available.

The Bondmeter is robust and transportable. It is designed to operate from 110 or 220-240 V 50 cycles mains, and weighs only 38 lb in its foam-lined transport case. At maximum sensitivity the loading is 30 watts. It will indicate visibly any area of a liner where the white metal is not bonded to the steel, as may result from indifferent tinning or blistering due to the escape of hydrogen from the steel shell.

In operation the surface probe is passed over the lining and the result is displayed on an optical galvanometer and compared to a reference standard. One essential requirement is that the material forming the bearing shell or housing for the white metal possesses an electrical conductivity not less than that of the lining itself. It should be noted that some cast irons do not meet this requirement and the Bondmeter cannot

be used with them. In general the thickness of the white metal under test should not exceed 0·1 in (2·5 mm) although results have been obtained with thicker linings where the adhesion has not been particularly good. *The Hoyt Metal Company of Great Britain Limited, Deodar Road, London, SW15.*

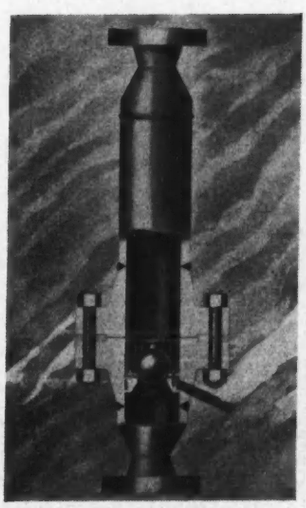
DESUPERHEATER

Variable Orifice Control

CLOSE control of steam temperatures is achieved in the desuperheater illustrated by the action of the variable orifice.

The orifice is closed by a ball which is lifted by a pressure of about 3 lb per sq. in so that the pressure drop across the orifice remains constant at all flows. Cooling water at an excess pressure of 30 lb per sq. in or above is fed to a trough surrounding the orifice where it meets the steam at its point of highest velocity. This causes extreme turbulence and breaks up the water into minute particles that immediately vaporize. The steam flow is upwards so that any unvaporized droplets remain in suspension until absorbed. Control of the cooling water is conventional.

It is claimed that good control is possible from 100 per cent to 2 per cent of full load, and that the final steam temperature is held to within $\pm$ 5° F of the required setting to as low as 10° F above saturated temperature. Dry superheated steam at the correct temperature



is produced at only 20 ft downstream of the desuperheater. *Copes Regulators Limited, 9 Southampton Place, High Holborn, London, WC1.*

ROTARY PUMP

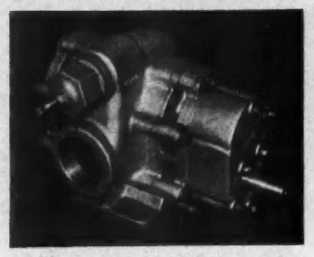
Lightweight, High Capacity

DESIGNED for handling a variety of liquids, the Waterous rotary pumps are now being made in this country.

The units are compact and light in weight with a high capacity. They may be assembled for clockwise or anti-clockwise rotation as required, and for top or bottom drive. The major components are the rotor shaft and pilot gear assembly, and the body and head assembly.

The rotor shaft and pilot gear consists of two three-lobed rotors mounted on stainless steel shafts. The rotors are available in various materials to suit the duty for which they are employed. Hardened alloy steel gears pinned to each shaft keep the rotors in phase with a constant clearance between the lobes. The mechanical seals at the ends of the shafts are adjustable for wear. The shafts run in sealed ball bearings.

The body and head assembly includes the body, headplates, relief valve, and related parts. The body and head plates are available in various materials and the



adjustable relief valve prevents damage due to excessive pressures.

The rotor lobes mesh in the same manner as a pair of gears, disengaging at the suction side. Liquid is trapped between the lobes and the body and carried round until forced out by the re-engagement of the lobes on the discharge side. The pumps are self-priming and can handle high or low viscosity liquids. Rotor lengths are 7 in and 5·3 in, the capacities with a fluid of 4,500 Redwood No. 1, being 250 gpm and 190 gpm respectively for a rotor speed of 900 rpm. *Sir George Godfrey and Partners Limited, Hampton Road West, Hanworth, Middlesex.*

WELDER

Carbon Dioxide Process

A CONSTANT potential dc welding unit for use with the carbon dioxide process has recently been introduced into this country.

The equipment is semi-automatic and consists of a lightweight hand gun; an integrated wire drive and control unit; and a 600 amperes constant potential source. The hand gun has a pistol grip and is said to be easy to use. It is water cooled and sealed without O rings. The wire drive unit can be mounted on top of the rectifier or alternatively slung from a rail or gantry to provide easy access to the weld. It consists of a mechanically governed wire feed motor, dual drive feed rolls, post purge gas and water timers, and control relays. It is contained in a cabinet 2 ft square by 1 ft deep.

The silicon rectifier unit is rated for continuous duty. Slope control is provided from flat to drooping. The voltage is from zero to 45·4 volts at rated load. There is a built-in 2 kVA transformer to provide power for accessories and a

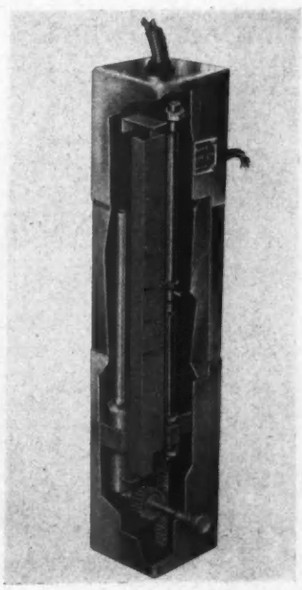
fixed 180 A outlet for tack welding with normal stick electrodes. *Arc Manufacturing Company Limited, Actarc Works, Nitshill, Glasgow, SW3.*

LIQUID LEVEL CONTROLLER

Electronic

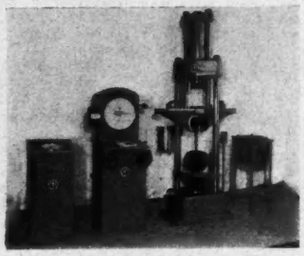
REMOTE control of the amount of liquid pumped into a tank can be easily achieved by the level controller illustrated.

Presetting is carried out by an adjustable photo-electric cell which can be moved up and down the sighting glass by a control knob mounted on the outside of the Telegauge casing. The scale can be marked in gallons or in weight as desired. An airline connects the gauge to the tank or vat so that the liquid level is constantly recorded by the sighting glass. Leads from the photocell are connected to an amplifier from which a signal can be derived to operate a warning light or buzzer, or to give direct control of the pump, motor. Alternatively a feed valve can be shut off. It is also possible to fill two or more tanks from one pump unit using one set of motor control gear in conjunction with a selector switch and a Telegauge with photocell for each tank. *H. M. Hobson Limited, Fordhouses, Wolverhampton, Staffordshire.*



UNIVERSAL TESTING MACHINE

Static or Dynamic



STATIC and dynamic tests up to maximum loads of 80,000 lb can be carried out on the UPD40 universal testing machine.

The full range of possibilities includes tenstile, compression and bending tests under constant loading or constant rate of loading, and tests at elevated temperatures. Provision is made for recording directly the strain diagram at magnifications up to 2,000.

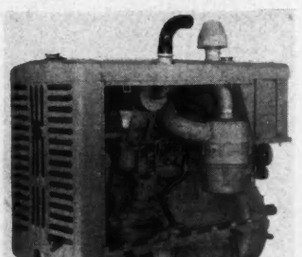
The machine itself has a hydraulic cylinder for applying the load, the hydraulic pressure being directly proportional to the load on the specimen. A pendulum dynamometer on the control console is used to indicate the load at any time and five ranges are available. Also in the control console are the hydraulic pump and the control equipment for applying the load. This includes a special valve for fine adjustment.

The control has a sensitive follow up action so that the rate of loading is always proportional to the movement of the handwheel. A preselector for setting the speed at which the load is applied can be fitted. The gripping heads can be adjusted for specimen size by push button control.

Alternating loads for dynamic tests are applied by a mechanism at the bottom of the machine, under the control of a separate panel, allowing frequencies from 1 to 60 cycles per minute to be applied. The dynamic loading can be superimposed on the static load. Tests can also be carried out at elevated temperatures by using an adjustable air furnace which is suitable for operation up to 1,000° C. *Mohr and Federhaff AG, Mannheim 1, West Germany.*

POWER PACK

Continuous Rating of 85 hp



NOW available in power pack form is the Six 354 industrial diesel engine which is continuously rated for 85 hp at 2,000 rpm.

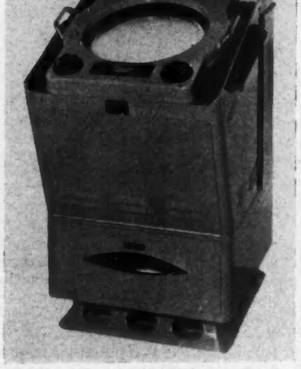
The intermittent rating of the unit is for 104 hp at 2,400 rpm so that the pack provides a lightweight power unit capable of exceeding 100 hp. A wide range of back ends with No. 1 or No. 2 SAE housing is available to suit various makes of clutch, fluid or flexible couplings, or torque convertors. Complete power take-off units incorporating a clutch can be supplied.

In its complete form the pack is supplied with radiator, fuel tank, fuel oil piping, instrument panel, 12-volt starting equipment, stop and throttle controls, air cleaner, exhaust silencer, radiator cover, sheet metal top canopy and detachable side panels. The instruments offered include a lubricating oil pressure indicator, water temperature indicator, dynamo charge warning light and tachometer.

The basic Six 354 engine used in the pack employs a mechanical governor incorporated in the vertically mounted distributor type fuel injection pump. The engine has a bore and stroke of $3\frac{7}{8}$ in by 5 in respectively. It has pressed-in dry cast iron liners, thin wall pre-finished main bearings and a seven-bearing crankshaft. The engine is available in several forms, from the bare unit up, and is suitable for heavy contractors' plant of all kinds. *F. Perkins Limited, Peterborough.*

RADAR CONSOLE

Direct Range and Bearing



DIRECT readings of distance and bearing can be obtained from a new 16 in radar display console.

The unit is suitable for use with both 3 cm and 10 cm equipment and incorporates Interscan, a continuously visible line originating from the ship's own position. From the variation in length and direction of this line, range and bearing information can be obtained in the shortest possible time and with great accuracy on any number of targets and on any type of presentation, relative or true, stabilised or unstabilised. This is particularly useful in congested waters where continuous information regarding change of range and bearing must be maintained for several ships simultaneously.

Other new features of the unit include a daylight viewing hood permitting simultaneous viewing by two operators in normal direct lighting; built-in true motion; seven range scales from $\frac{3}{4}$ to 60 nautical miles; and variable differentiation giving control of picture sharpness to suit physical characteristics of the locality. *Decca Radar Limited, Decca House, Albert Embankment, London, SE11.*

PACKAGED GAS BURNER

Forced Draught

DESIGNED for use with towns gas with a calorific value of 500 Btu per cu. ft is a new range of packaged burners.

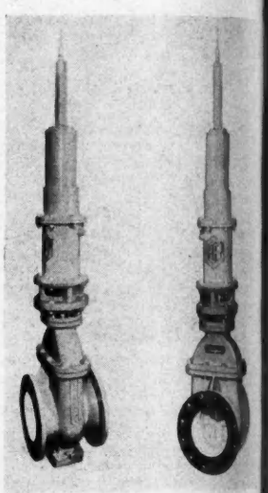
There are five models in the range, with outputs from 100,000 to 4,000,000 Btu per hour. Corresponding gas consumptions are from 265 to 10,700 cu. ft per hour. The burners will operate at a negative draught of 0·1 in water gauge at the front plate subject to the chimney dimensions being adequate for the evacuation of the gases. All component parts are in the one assembly so that the units can be fitted in the shortest time and will occupy the smallest space.

The main gas jet is integral with the casing, housing a directly driven fan actuated from an externally mounted motor. The gas pressure governing device, the gas pilot jet and the flame failure control are attached to the smaller models, but in the larger sizes they are fixed to the pipework adjacent to the burner. The pilot jet consumption ranges from 4 to 10 cu. ft per hour according to the size of burner. Operation is fully automatic under thermostatic control combined with high-low flame modulating control (when used) giving economic consumption.

The gas burner is a cast iron Gaso type with the quarl cast in Durax refractory. The motors driving the centrifugal fan range from $\frac{1}{6}$ hp to $\frac{1}{4}$ hp and are available for standard voltages. A safety cutout is provided by a fusible link over the front of the combustion chamber set to operate at 155° F and connected to the main gas valve. Electric pilot ignition can be provided at extra cost. *Prior Stolzy Limited, 1-3 Brandon Road, York Way, London, N7.*

HYDRAULIC VALVE CONTROL

Simplified Piping



SIMPLIFIED pipework is one of the claims for a new hydraulically operated valve actuator.

The units are particularly designed for use in tankers on the larger sizes of cargo valves. The actuators are mounted directly on the valve stem with full protection and sealing against corrosion. Inspection plates are provided so that adjustments can be made to the valve gland without disturbing the actuator assembly.

The piping to the actuators is simplified because a pressure ring system is used instead of the separate flow and return runs for each valve as in more conventional systems. This affords a considerable saving in the quantity of pipe required and also in the remotely positioned selector valves previously employed. The new design is virtually an extension of the firm's standard hydraulic actuator system which embodies a cable control showing at all times the actual opening of the valve and enabling the operator to close the valve appropriately. Savings in time can also be effected. *Hydraulics and Pneumatics Limited, Wulfruna Works, Villiers Street, Wolverhampton.*

CREEP TESTER

12 Specimens Simultaneously

UP TO twelve specimens can be tested simultaneously in a creep testing machine.

The machine has temperature control, switchgear, and extensometers all built-in and does not require a temperature controlled room. The specimens are arranged in three strings of four, and each string is provided with a separate loading device so that three different loads can be applied at the same time. Loads are variable from 550 lb to 4,400 lb and the loading device is accurate to within ± 1 per cent. By selecting specimens with different diameters the spread of the tests can be extended.

The strings of specimens are suspended by universal joints and loaded at the lower end by a two-lever system which can be balanced to zero. A monitor provides against excessive temperature and a device removes the load if the specimens should cool accidentally. *Mohr and Federhaff AG, Mannheim 1, West Germany.*

X-RAY UNIT

300 kVp Capacity

SHOWN in the illustration is the mobile version of a 300 kVp X-ray equipment, one of a large range.

The set is also available as a fixed laboratory unit and both types are suitable for the examination of steel specimens up to 3 in or 4 in thick, depending on the technique used and the type of results required. The units are robust and the movement of the head is effected hydraulically. The 150 kVp hollow anode tube can be used with this set.

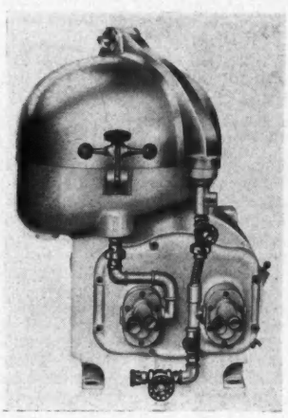
The control unit incorporates a voltage stabiliser to accommodate changes from 200 to 250 V while holding the tube filament at a constant temperature. The stepless regulator enables the full range from zero to 300 kV to be applied to the tube. A compensating device adjusts for various tube currents, eliminating the need for calibration chart. A synchronous exposures timer is fitted.

A double Greinacher circuit is used in the generators, with metal rectifiers which are claimed to give stabilised tube performance and lower replacement costs due to their long life. The tube shield is shockproof and rayproof, and incorporates a translucent window to observe the filament in operation. The shield has a low inherent filtration and so may be used for radiography having penetrations less 100 kV. A rotatable centre section may be turned 200° without movement of the cables. The tube is continuously rated at 300 kV 12 mA with a focal spot of 4 mm by 4 mm. It is oil cooled.

The tube stand on the mobile truck has a parallel link motion actuated by a hydraulic jack. The vertical height range is from 3 ft to 11 ft and the angular rotation of the column is 180° in both directions. Maximum reach from the edge of the truck is 5 ft and the horizontal traverse is 12 in. *Pantak Limited, Vale Road, Windsor, Berkshire.*

OIL PURIFIER

Single-Stage Self-Cleaning



A SINGLE-STAGE self-cleaning oil purifier is the Nozljector DHM-1 unit illustrated.

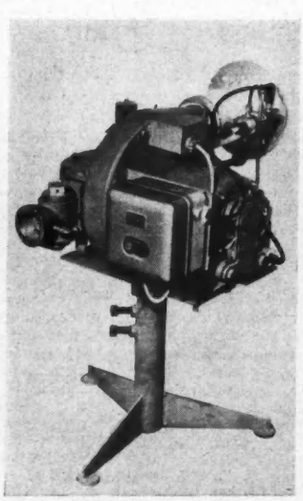
This embodies the Gravitrol 1000 centrifuge capable of handling up to 2½ tons per hour and therefore suitable for ships of from 3,000 to 12,000 hp. The unit is supplied complete and occupies only 48 in by 37 in of floor space. It stands 45½ in high when closed, opening to 61 in. Included are built-in feed and discharge pumps and a recycle system, all on the same baseplate.

The centrifuge and pump motor is rated at 10 hp; it is totally enclosed and fan cooled. The recycle pump motor is of only fractional horse power, but is also totally enclosed. The centrifuge bowl is made throughout of stainless steel and has an internal diameter of 10 in. It weighs 107 lb. The rotational speed of 8,000 rpm gives a centrifugal force of 9,070 lb maximum. The whole unit weighs approximately 12½ cwt.

Instruments included in the set are sight glass, pressure gauge and thermometer. Heating and cooling coils are fitted to the recycle tank so that there is close temperature control. There are twin strainers. The covers are cast aluminium, the frame cast iron, and the tanks are mild steel. *Sharples Centrifuges Limited, Tower Works, Doman Road, Camberley, Surrey.*

GAS BURNER

Packaged Conversion Unit



A PACKAGED gas burner is now available for the conversion of central heating boilers, process air heaters, and other industrial plant.

To obtain the maximum thermal efficiency, the unit has forced draught which also reduces the site work needed to perform the conversion and makes it independent of flue conditions. The arrangement is also considered to be the most favourable for the reduction of heat loss during shutdown periods. In addition the size of the gas carrying components can be reduced.

Features of the burner are that it is unit tested; high thermal efficiency is possible, up to 75 per cent at boiler rated output; built-in flame failure equipment for safety; and very low pilot flame consumption, the maximum being 5 cu. ft per hour. The negligible air flow through the unit during shutdown reduces running costs and the virtually indestructible burner keeps maintenance to a minimum. Accurate control of the combustion air is provided and the burner will therefore run with the minimum of attention and without soot formation. *The Gas Council, 1 Grosvenor Place, London, SW1.*

SIGHT FLOW INDICATOR

Spinner Type

A RECENT addition to the range of sight flow indicators is the simple low priced model, type 400 illustrated.

This unit is suitable for use with working pressures up to 40 lb per sq. in, the limitation being the glass dome. The remainder of the indicator will take much higher pressures and a version is available using armour plate brand glass which will extend the range.

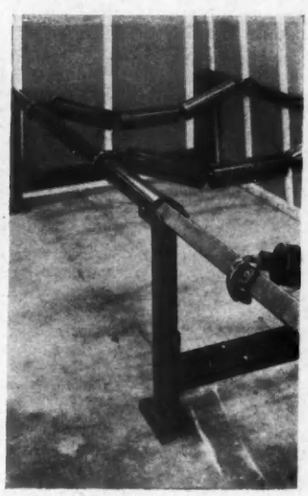
The body of the unit is in good quality gunmetal and, as previously mentioned, the dome is heat resisting glass. The internal spinner is nylon, and is mounted on a stainless steel spindle. The joint washer between the glass and the gunmetal body is Neoprene and there is an O-ring insulating washer between the glass and the clamping ring.

The nylon spinner limits the operating temperature to that of boiling water, which is normally sufficient. For higher temperatures a metallic spinner can be fitted. The rotation of the spinner can be observed from almost any angle as it stands proud of the body, and the simplicity of the design makes the unit both effective and reasonable in cost.

Typical uses of the indicator are for cooling water to compressors and cooling water for spot welding plants. At present models are being made for pipe sizes of ½ in, ¾ in, and 1 in; other sizes will be available later. The unit is approximately 3 in long and the dome 1¼ in diameter. *B. Rhodes and Son Limited, Danes Road, Crow Lane, Romford, Essex.*

BELT CONVEYOR

Variable Trough



A NEW type of belt conveyor structure has recently been developed.

Known as the MECO Suspended Idler type CS930, it is suspended from tubular stringers. As the load on the belt increases, the idlers automatically increase their troughing capacity to keep pace with it.

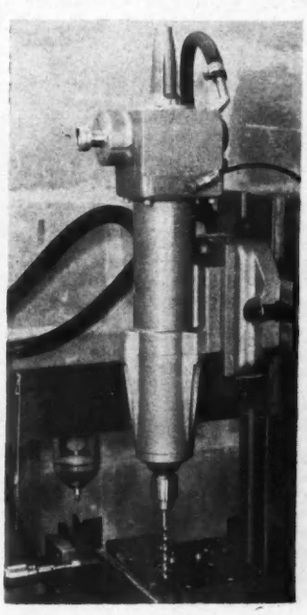
When the belt is running empty, the troughing angle is approximately 20°. This increases with the load to a maximum of about 35°, acting against heavy springs which are housed wholly within the side rolls of the three-roll idler.

One useful application for the Suspended Idler may be in the bulk handling of granular materials, particularly at docksides, where its adaptability and flexibility will be of value in reaching ships at various berths.

With its high spillage-free capacity, boltless assembly and lightweight components, this new equipment should be equally suitable for permanent and temporary conveyor-belt installation, and suitable for a relatively wide range of applications. *Mining Engineering Company Limited, MECO Works, Worcester, England.*

AIR DRILL

Unit Head Construction



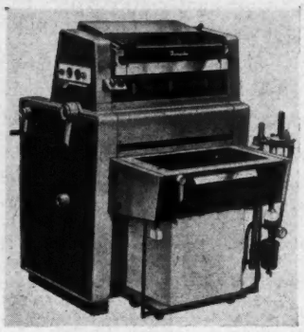
THE unit construction of a new drill driven by compressed air allows several to be used together.

The drill, which is shown in the illustration, works from a standard air line and is made up of three basic sections. These are the tool holder, the drive unit and the valve block. Built into the drive unit is a device that allows for fast approach of the toolholder and adjustment of the tool feed to suit the work. The valve unit houses all the necessary controls to stroke and retract the tool holder according to a chosen cycle, and signals are automatically relayed from one station to the next so that automatic sequence operation is obtainable.

Several of these tool units may be coupled together and by using them in conjunction with a suitable indexing work table a fully automatic sequence may be obtained. The machine is capable of carrying out such operations as reaming and broaching as well as drilling. *Baldwin Industrial Controls, Dartford, Kent.*

OFFSET PRINTER

For Lightweight Papers



THE CHAIN DELIVERY mechanism of the new R30/95 offset printing machine makes it particularly suitable for lightweight papers of poor body.

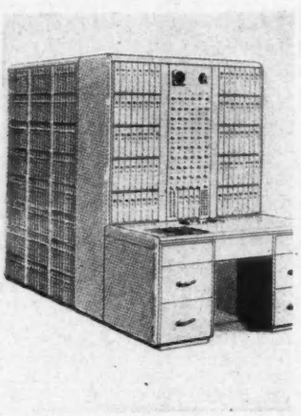
The chain delivery also gives advantages when coated papers with a fair amount of colour are handled. Stripping from the blanket is even and complete, and the sheets are placed gently in the pile so that the impression is not scuffed. It is also possible to take the image right up to the side edges of the paper as no allowance need be made for strippers or delivery runners.

The delivery platform is self-lowering and is mounted on smooth running castors enabling it to be wheeled away when fully loaded. Side and back joggers keep the pile in register and the machine is fitted with stroker side-lay as standard.

The metal plate size is 17¾ in by 14½ in and the printing area is 17½ in by 13 in maximum. Any size of paper from 20 in by 13½ in to 6¾ in by 4⅜ in can be handled, and any weight from Large Post 7 lb to 6-sheet. Automatic adjusters set the cylinders to the thickness. Suction feed is operated by a dry vane rotary pump. The automatic Rotafount patent damping system is used and there are therefore no damping rollers. Speed is up to 6,000 impressions per hour and the register is hairline. Power is supplied by a 1 hp motor and the floor space needed is 3 ft 5 in by 4 ft 1 in. *Rotaprint Limited, Rotaprint House, Honeypot Lane, London, NW9.*

REACTOR SIMULATOR

For Operator Training



A SPECIAL purpose analogue computer which is capable of simulating the behaviour of a complete atomic power plant is to be installed by the United Kingdom Atomic Energy Authority at the Calder Operations School.

This machine has a capacity of 200 amplifiers. Although it has been basically designed to simulate a Calder Hall type of reactor, it is said by the makers to be relatively simple to convert for use with an advanced gas-cooled reactor.

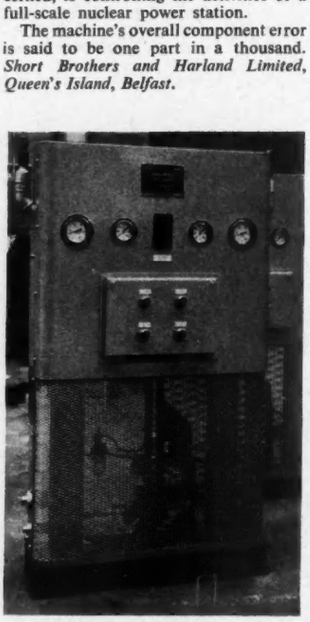
The simulator comprises a console and five racks of equipment. For the purposes of simulation, the reactor which it represents is considered to be split into three zones.

A mock reactor control desk, similar to those being supplied to new power stations, will be used with the reactor. The instruments on the desk will receive their information from the simulator, which will also interpret any control adjustments made by the trainee operator and revise its signals to the desk instruments accordingly. Thus the operator will receive his instruction at a control desk which, as far as his senses are concerned, is controlling the activities of a full-scale nuclear power station.

The machine's overall component error is said to be one part in a thousand. *Short Brothers and Harland Limited, Queen's Island, Belfast.*

GAS DRIERS

Solid Dessicant Type



CONTINUOUS extraction of moisture from air or other gases is the aim of the Holmes-Kemp driers.

These units are of the solid dessicant type operating on a preset cycle, the period of drying being followed by one of heating, then cooling to drive off the adsorbed moisture. Twin towers enable continuous drying to be carried out. Several types of dessicant can be used, depending on the installation. Prefilters are fitted where the gas to be handled is laden with oil mist or other impurities.

The smaller sizes have reactivation elements embedded in the drying towers. Either steam or electricity can be used, with manual, semi-automatic or fully automatic control. A small bleed of dry gas is used to carry the moisture out of the towers during reactivation. This gas also flows during the cooling period removing the need for fans and an external supply of cooling water. The larger sizes are convection cooled and have a separate reactivation system of fan, heater and cooler. One volume of the gas being handled is recirculated continuously to avoid contamination. *W. C. Holmes and Company Limited, Turnbridge, Huddersfield.*

POWDER PUMP

Small Batch Transfer

THE JUNIOR powder pump is designed for the transfer of powdered materials by pipeline when comparatively small quantities are involved.

The pump can also be used as an automatic device for dosing or blending powders or for bleeding off from draw-off points. The principle used in the design produces a positive and uniform rate of displacement which smoothly generates the flow of powder through the pipes. Injected air is used to maintain the powder in a fluidised state but not for blowing it through the line. Only a small amount of air is therefore needed.

The unit incorporates the driving motor and push button starter. The rate of discharge can be varied from small amounts up to about 5 cu. ft per hour. Motors are available for standard mains supplies.

As examples of the discharge rates possible, a powder of density 5 lb per cu. ft could be transferred at 3 lb per hour with a pump speed of 25 rpm, or at 22 lb per hour if the speed was increased to 200 rpm. For a powder of 25 lb per cu. ft, the corresponding figures would be 14 and 112 lb per hour and for one of 55 lb per cu. ft, they would be 30 lb per hour at 25 rpm and 180 lb per hour at 150 rpm. The inlet branch is 3½ in bore and the outlet can be from ½ in to 1 in according to the pumping conditions. Overall measurements are 25¼ in by 13 in by 19½ in high. *Mono Pumps Limited, Mono House, Sekforde Street, London, EC1.*

STUD WELDER

Uses Capacitance Technique

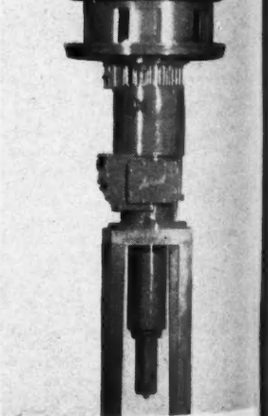
NOW to be marketed in this country are the stud welding machines made by Omark Industries Incorporated.

This system operates on the capacitance or stored energy principle giving a percussive effect. It is claimed to have several advantages over resistance and arc welding particularly where thin plates are involved. Machines are available for bench mounting or as transportable units (illustrated) for *in situ* work.

Stud sizes, either threaded or unthreaded, can range up to ¼ in diameter and plates can be as thin as 0·020 in without being distorted or suffering from weld burn. No flux, ferrules, or inert gases are needed. Welds are produced by discharging a high direct current at low voltage through a patented tip at the end of the stud. The tip initiates the arc on contact with the material, ionisation results, and a current flows which melts the face of the stud and a similar area of the workpiece. The technique is suitable for welding aluminium, mild steel, stainless steel, brass, copper, titanium, and other materials. *Kerry's (Ultrasonics) Limited, Warton Road, Stratford, London, E15.*

ELECTRIC WHISTLE

3 Mile Range in Still Air



LATEST addition to the range of electric whistles is the type G Mk. IV illustrated.

It is claimed that this model gives a sharper and more powerful note than earlier ones and can be heard over 3 miles in still air. The solenoid signalling device is direct acting, being mounted immediately under the driving motor. This has reduced weight, improved appearance and given sharper operation.

The whistle is fitted with a 6 hp motor rated for 15 minutes. A slow running and heating device is incorporated to keep it clear of ice. The sound frequency is 350 cycles. Overall dimensions of the unit are 22 in by 22 in by 60 in high, increasing to 65 in high when sounding. The net weight for both dc and ac versions is 300 lb. In the controller are the contactors and relays for manual operation from the bridge and a timing unit for automatic fog sounding. *Service Electric Company Limited, Secomak Works, Honeypot Lane, Stanmore, Middlesex.*

Companies

Rising Turnover and Falling Profits

EXAMINATION of the ASSOCIATED ELECTRICAL INDUSTRIES' ten year profit statement shows how sales have risen from £63 million in 1951 to three times that amount—£215 million—last year. Over the same years the group trading profit before tax, rising from £9·12 million in 1951 to £15·25 million in 1955, fell again to £8·49 million in 1960.

Last year's turnover of £215 million was a 3·4 per cent increase on the year before and "a substantial part" of the total output was exported. The order position improved during the year. Home and overseas orders received during the year by all the AEI companies were worth £223 million, compared with £182 million in 1959. At the year's end there were £181 million of orders in hand, against £173 million in 1959.

The annual AEI review gives the following *How your Money is Used* table:

	s	d
Materials	8	7
Wages and salaries ..	6	1
Operating expenses ..	3	11
Depreciation		7
Tax (including tax on dividends		4
Profits retained in business ..		1½
Dividends		4½
	20	0

1959's balance sheet carried £750,000 set aside as a special reserve against possible loss on the completion of Berkeley Nuclear Power Station. This year no such entry appears. AEI have now delivered four turbine generators and eight of the sixteen gas circulators for Berkeley.

Four generators producing a total of 570 MW have been ordered for the Dungeness station being built by the Nuclear Power Group, of which AEI is a member. In the export market, a 220 MW turbine generator has been ordered for Douglas Point, Ontario.

In the research field a new magnesium alloy has been developed, Magzan 2, and it may have extensive future use in nuclear reactors. Magzan 2 is able to bear loads at 500° C, which is within 150° C of the melting point of magnesium. It also has low neutron absorption.

AEI are also closely concerned with the space research effort of both the United States and the USSR. Mass spectrometers produced in the Instrumentation Division are sold all around the world, and in Russia and the USA. Using one of these instruments it is possible to obtain a continuous direct analysis of the gases flowing through the lungs during a breathing cycle. This is essential to the study of a pilot's reactions under conditions of stress.

On the lighting side of AEI's companies, the MAZDA lighting contract for the 26 storey Shell Centre on the South Bank, London, is thought to be the largest contract of its kind ever placed in the United Kingdom. A lamp of rather more specialised application is the all-glass sealed beam lamp designed by AEI engineers which is being used in VGPI, the British Visual Glide Path Indicator system developed at the ROYAL AIRCRAFT ESTABLISHMENT, and to be installed at all major British airports and at RAF stations. This system has won approval in the United States and there are hopes that it may be recommended by the International Civil Aviation Organisation.

A significant part of AEI's contribution to the development of the United Kingdom's industrial capacity is its work for the steel companies now in the middle of their expansion programmes. At RICHARD THOMAS AND BALDWIN'S new Spencer steelworks, at Llanwern, near Newport, Monmouthshire, AEI are supplying £3 million worth of equipment. Their contracts cover compressors, motors and control gear.

The trend towards automation in the steel industry has led to the formation of the jointly owned and financed AEI-DAVY UNITED STEELWORKS AUTOMATION UNIT.

South Africa and the British Manufacturer

Since the decision by South Africa to leave the Commonwealth there has been plenty of political discussion, but not much information on the likely future material developments in trade with one of the United Kingdom's most important markets for manufactured goods.

One of the little known aspects of the South African Government's plans is their intention to undertake very substantial industrial expansion in the years ahead. The large orders with the British electrical industry for electric railway power units and so on have been noted but there also exist plans for a major extension in the mining industries, in manufacturing, transport and in the necessary provision of power supplies, where some £200 million is due to be invested over the next ten years.

A United Kingdom company with direct experience of South Africa is the MITCHELL ENGINEERING GROUP, whose £2 million steam generating plant at a Transvaal power station is due to be commissioned this July. A contract for an extension to this station, involving two of the largest capacity boilers in the Union and worth £2,250,000, has now been awarded to Mitchell's. Mitchell have their own subsidiary in Johannesburg, MITCHELL ENGINEERING PROPRIETARY Limited, staffed entirely by South Africans, including South African trained professional engineers.

One of the marks distinguishing South Africa from many other sections of the export markets is that it is not the scene of no-holds-barred battles over the length and cheapness of credit. South Africa, for all the decline of its stock market position, has the money to further its industrial advance.

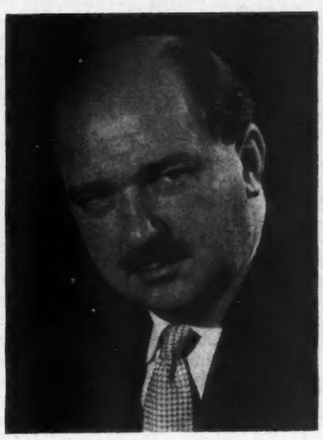
This is not to imply that the balance of payments position is not serious, and one of the Government's long term plans for the improvement of the nation's economy is the steady raising of the locally manufactured proportion of even capital goods used in the Union. This means for Mitchell Engineering that some 80 per cent of their plant sold in South Africa is made there. From Britain go only the special mechanical parts, the very heavy boiler drums for which there is not yet the local production capacity. Increasingly it is a business of selling engineering knowledge and skill, and this trend is one which the Mitchell executives see no sign of slacking off.

Surveying their export contracts of the last 12 months, in Greece, Turkey, North and South Rhodesia, Venezuela, New Zealand and Australia, the Mitchell company report Australia and South Africa as placing the majority of the orders.

Australia possesses the same essential features—as an industrial export market—as South Africa; the money is there and the credit auctions of the less developed nations do not go on. There is also the same drive towards increasing the local manufacturing capacity.

Top Flight Changes at Imperial Chemical Industries

Among a number of high level changes of post in IMPERIAL CHEMICAL INDUSTRIES Limited, Mr. St. John de H. Elstub (inset), who was responsible for the design of the first British liquid fuel rocket motor, has been made chairman of the METALS



DIVISION. He succeeds Mr. M. J. S. Clapham, a member of the Albemarle Committee on the Youth Service, who has been appointed an ICI director, functioning as an overseas director.

Mr. Elstub, who was educated at Rugby and took an honours degree in mechanical engineering at Manchester, served for three years as an engineer with the ICI Billingham division. He then joined the RAF in 1939 and served for six years, as operational bomber pilot, as a flying instructor and as an armament officer on technical intelligence and rocket design.

Rejoining ICI in 1947 from the rocket propulsion department of the Ministry of Supply, Mr. Elstub became deputy chief engineer of the metals division. Four years later he was seconded as director in charge of Summerfield Research Station, a rocket research establishment managed by ICI for the Ministry of Aviation. A year later he resumed full time duties as metal production director of the Metals Division and became joint managing director in 1957.

Mr. Elstub is also chairman of AMAL Limited, an ICI subsidiary, and a director of YORKSHIRE IMPERIAL METALS Limited, the tube manufacturers jointly owned by ICI and YORKSHIRE COPPER WORKS (HOLDINGS) Limited.

Mr. Clapham, who has been chairman of the Metals Division since January, 1960, and now becomes an ICI director, entered the industry by a route that could hardly have been more different from his successor's. Taking an honours degree in Classics at King's College, Cambridge, in 1933, he joined the University Press as an apprentice.

After three years with a Bradford printers he joined ICI Metals Division in 1938, assisting in the running of the Kynoch Press, where he became manager in 1940. Two years later he was seconded to the directorate of TUBE ALLOYS (ATOMIC ENERGY) to develop the work started in the Kynoch Press on producing barriers for isotope diffusion plant.

Successively personnel manager and personnel director of the Division, Mr. Clapham became a joint managing director in 1952. He is also a director of Pyrotenax, Yorkshire Imperial Metals and IMPERIAL ALUMINIUM.

Fire Extinguishers' Record Output and Exports

With fire losses in Britain in 1959 and 1960 standing at around £44 million a year and with the toll if anything worsening since then concern among managements on methods of fire prevention has been increasing. On the official side the installation of fire extinguishers in factories became compulsory from 1 December, 1960, with the passing of the new Factories Act. Ministry of Labour recommended standards were also considerably raised.

In the thick of all this is NU-SWIFT INDUSTRIES, perhaps the largest single concern in the world concentrating on the design and manufacture of portable fire extinguishers. A closely integrated organisation, the company's activities cover research, development, design, manufacture, marketing and, in the United Kingdom the sale of fire extinguishers direct to the user.

It is the deliberate, carefully thought out policy of the Nu-Swift management to produce a limited but comprehensive range of extinguishers and to be able to deliver promptly without building up high stocks.

The fire extinguisher is by no means a piece of equipment that comes off the wall once in a lifetime. During 1960 some 35,560 pressure chargers were returned to Nu-Swift for recharging. The firms who already have Nu-Swift equipment provide an important part of the order book. Forty per cent of 1960's orders for delivery in Britain came from companies making repeat contracts.

The trading profit has not far short of doubled in the last two years as the following table shows.

Three Year Profits Table

	Trading profit before depreciation and taxation	Net profit after depreciation and taxation
	£	£
1958 ..	136,400	56,529
1959 ..	179,959	80,762
1960 ..	226,784	106,424

Overseas, direct exports account for a third of the company's output. Sales are made in more than 85 countries.

The new statutory requirements introduced in Britain include provisions covering the maintenance of fire extinguishers in factories. This is likely to mean that the Nu-Swift service department, which was growing rapidly during 1960, will continue expanding rapidly.

Efficiency of Coal-Fired Industrial Boilers

Recent developments in the burning of coal in industrial boilers are discussed. A comparison is made between tests using coal and oil fuels.

By C. D. Gunn

Technical Director, Cochran and Co., Annan, Limited

THERE is nothing new in the mechanical firing of boilers and a large number of patents were issued during the last century covering various ingenious devices for this purpose. It is interesting to note that one of the earliest of these inventions was the chain grate[1] and that this form of firing appliance is at present one of the most popular for boilers varying from small domestic units of ½ million Btu per hr up to water tube boilers of steam output equivalent to 250 million Btu per hr.

Hayward[2] presented a comprehensive paper on the subject of the development of the smaller chain-grates drawing attention to the new application of these appliances to shell-type boilers. The chain-grate has since prospered to the extent that, currently, this form of firing competes almost solely with the coking stoker for firing shell-type boilers. The present author[3] reported experiments carried out by the British Coal Utilisation Research Association to determine the effects of coal characteristics on boiler performance using an appliance of the same type as that described by Hayward. The main findings of this work were that small coal of all ranks should be burned efficiently and effectively on a chain-grate in a shell boiler provided that the surface moisture content of the coal was about 1½ per cent for every 10 per cent of the coal passing ⅛ in mesh. This programme of work, which occupied several years, was further described by MacDonald and Murray[4] who assessed the effects of varying quantities and qualities of ash. They showed, among other factors, that the effect of ash was more marked with coals containing a high percentage of fines than with graded coal, the loss of efficiency being between 0·2 per cent for graded coal and 0·8 per cent for fine coal for every 1 per cent of ash present. With fine coal, therefore, at 20 per cent ash content, a loss of efficiency of up to 16 per cent could be expected, compared with 1 per cent for a graded coal with an ash content of 5 per cent. The same authors enlarged on the subject in a further paper[5] and covered the effects of operating conditions.

More recently, Burke, Collins and Johnson[6] have described a miniature chain-grate particularly suitable for sectional boilers. The stoker described is intended to meet the special needs for space heating in large residential premises situated in smoke control areas. The controls described are entirely novel and even the fuel bed length is automatically regulated so as to maintain an optimum burning rate over a wide operating range. A turndown ratio of 20 : 1 is claimed, considerably higher than is at present possible with oil burners. Although designed for use in sectional boilers, this development, and especially the control principles, seem worthy of study in connection with industrial boilers. Complete mechanisation of coal feed and ash discharge have been achieved even on the relatively small scale of this kind of plant, and again the principles involved would appear to be worth studying with a view to applying them to larger industrial units.

Comparitive Efficiencies of Oil and Coal

The mechanical handling of coal and ash by established conveyor systems can amount to some 10 to 15 per cent of the cost of the boiler plant, and in small installations of, say, up to 10,000 lb of steam per hour, even more. In these smaller installations, mechanical handling by conveyors is rarely found, which means that manual labour is used almost exclusively. Apart from the near equality of fuel prices, this factor, as has been mentioned previously, would appear, to strongly favour the use of oil fuel, in which case boilerhouse labour can be eliminated.

Over the past few years many boiler plants old and modern, have been converted from coal to oil firing, and in most cases considerably improved boiler efficiencies have resulted. Fundamentally, there should be little difference between boiler efficiency on coal and oil, provided that coal can be burned with an excess air rate comparable to that used with oil. The following analyses of typical thermal losses from the same boiler will illustrate the point. They indicate a difference in efficiency of just over 2 per cent in favour of oil. It will be noted that this small difference largely arises from the fact that with coal there are appreciable thermal losses in the ashpit and in the stack solids. These losses are negligible with oil. To counteract this to some extent the loss due to moisture in the flue gases is less with coal than is the case with oil.

	Oil Per cent	Coal Per cent
Excess air	10·0	22·0
Dry flue gas loss	9·5	10·4
Loss due to moisture in flue gas	6·2	4·5
Loss due to grit carryover	Nil	0·5
Loss due to carbon in ash	Nil	2·5
Loss due to radiation and unaccounted	3·0	3·0
	18·7	20·9

Modern coal firing appliances, particularly chain-grates, are in fact capable of giving this kind of performance, and one is forced to conclude that the apparent considerable improvement in efficiency of oil firing compared with coal firing arises from operational factors, such that oil is inherently more controllable as a fuel than coal.

It will be appreciated that manual regulation, particularly where there are frequent changes in demand, can never be as satisfactory as automatic control. The elimination of the human element in boiler control on oil-fired boilers thus goes some way towards explaining the improvement in efficiency which has been obtained. A further explanation which applies

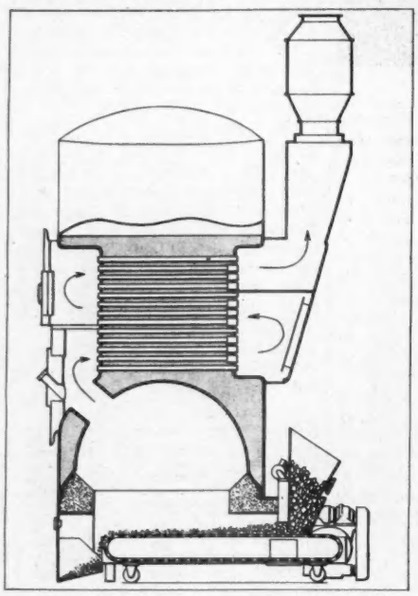


Fig. 1 (left) Cochran Series II vertical boiler similar to the one used in the experiments described in this article. It is shown fitted with a chain-grate stoker.

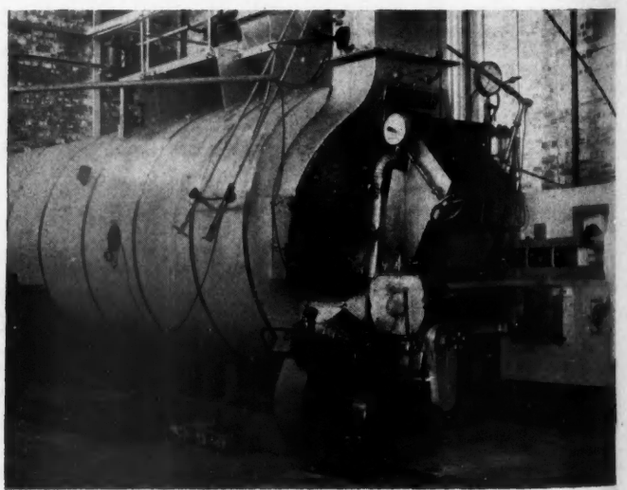


Fig. 2 (right) Cochran Sinupac boiler fitted with a chain-grate stoker and used for some of the experiments discussed in this article. The parts of the coking stoker also used during this work are shown alongside.

Vertical Boiler (Fig. 1)

Cochran "Series II"	7 ft 0 in dia. by 17 ft 3 in high (With three passes of smoke-tubes)
Rating on coal	4,950 lb per hr from and at 212° F
" " oil	4,950 lb per hr from and at 212° F
Steam pressure	100 p.s.i.g.
Firing appliance—coal	Hodgkinson chain-grate with modifications
" " oil	Brockhouse medium pressure air atomising burner
Induced draught fan (required for coal-firing only)	"Ax-cent"; new development by Keith Blackman Limited

Horizontal Boiler (Fig. 2)

Cochran "Sinupac"	7 ft 0 in dia. by 15 ft 8½ in over tube plates (One pass of smoke-tubes)
Rating on coal	7,000-9,000 lb per hr from and at 212° F
" " oil	9,000 lb per hr from and at 212° F
Steam pressure	150 p.s.i.g.
Firing appliances—coal (1)	Hodgkinson reciprocating feeder coking stoker
" " (2)	Hodgkinson chain-grate with modifications
" " Oil	Hamworthy rotary cup burner
Induced draught fan (Required for coal only)	Sturtevant type 4D, paddle bladed

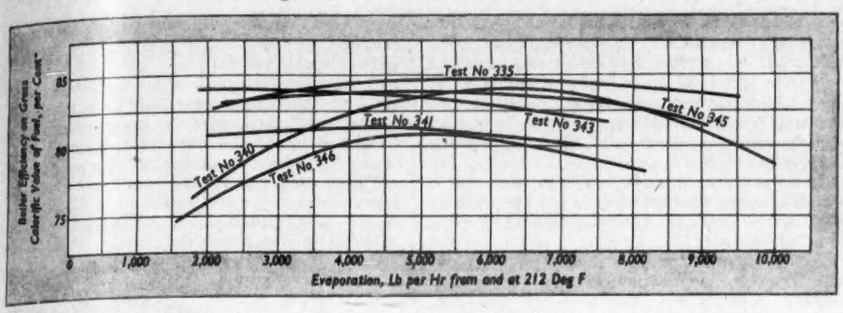


Fig. 3 (Left) Relationship between efficiency and load for 7 ft dia. Cochran Series II boiler on oil and different coals.

7 ft Diameter Series II Boiler

Test No.	Fuel	Gross CV Btu per lb	Rank	Moisture (per cent)	Ash (per cent)	Volatile matter (per cent)	Fixed carbon (per cent)	Ash fusion temperature (°C)	
333	950 sec oil	18,517	—	—	—	—	—	—	
353	A	11,280	801	3·2	19·9	25·8	51·1	14·00	Air dried basis
354	B	12,080	601	12·0	7·5	29·0	51·5	13·75	
358	C	13,270	202	7·0	8·0	13·8	71·2	—	

in many cases, arises from the comparison of modern oil-firing appliances, which have been carefully tuned to give optimum results, with outmoded coal firing methods which are in a bad state of repair.

Test Results

In order to resolve this " difference " between theory and practice, tests have recently been carried out on two different types of shell boilers using, firstly, oil fuel, and, secondly, different kinds of coal. Tests were carried out on the same two boilers, in the same experimental shop, and under the same experimental conditions. Particulars of the boilers are given in the tables below Figs. 1 and 2 on the previous page.

Both boilers are designed with an appreciable pressure loss through the smoke-tubes. The oil burning equipment in both cases is arranged to overcome this resistance by forced draught only. In the case of coal firing, however, this is not feasible and therefore, for coal-firing, induced draught fans are required.

Both boilers were tested in the research and development department of Cochran and Company, Annan, Limited, by complete heat balance. Efficiencies quoted are on the gross calorific values of the fuels and were determined by fuel and water measurement.

Fig. 3 shows the results obtained on the vertical boiler. The first tests carried out were on 960 secs fuel oil and an efficiency of over 82 per cent on the gross calorific value was attained. These tests are shown as test 333.

Some experimental work was then carried out using underfeed stokers, but these appliances were not successful in this application. The boiler was, therefore, raised on a skirt 1 ft 9 in high and a chain-gate fitted. It will be appreciated that there are several advantages peculiar to the vertical boiler layout:—(1) The chain-grate is mounted on rollers directly on the boiler-house floor, thus facilitating withdrawal. (2) The rear end of the stoker is quite near the rear of the boiler casing, making ash removal a simple matter. A barrow can be built into the boiler skirt or, alternatively, the ash can be ejected by means of a screw conveyor driven either from the front or the rear of the boiler. (3) In multiple boiler installations, the ash can discharge directly into a conveyor, running in a trench beneath the range of boilers.

From the first, the results on the chain-grate were most encouraging and it soon became evident that the boiler was capable of giving its full oil fired rating on a variety of coals at efficiencies almost as high as on oil.

Tests 353, 354 and 358 were carried out on small coals, none of them being easy. Coal A (Scottish) used for test 353 had a very high ash content, while Coal B (Durham) used for test 354 possessed quite strong caking and clinkering properties. Coal C (Welsh) was a medium swelling coal. In all cases the maximum burning rates on the grate exceeded 45 lb per sq. ft of grate area per hour.

It will be noted that the maximum difference between efficiencies on coal and oil amounted only to 1·9 per cent, the highest efficiency being on oil. The average ashpit loss over all the coal-fired tests was 2·8 per cent, the lowest being 1·4 per cent and the highest 4·1 per cent. On the other hand, this effect tended to be cancelled by the higher latent heat loss which is normally some 1·7 per cent higher for oil than for coal.

In all cases, both for coal and for oil, the nominal rating of the boiler could be exceeded.

Fig. 3 shows the results obtained with the horizontal boiler. In this case a peak efficiency of 84·9 per cent on the gross calorific value was obtained, but the load efficiency curve was extremely flat. The maximum difference in efficiency between coal and oil was (test 346) some 6 per cent and the minimum less than 1 per cent (test 340). The coal used in test 346 was distinguished by the tendency for an unusual amount of coal to drift forward from the grate into the ashpit, and appear as excessive ashpit loss (up to 4·8 per cent) and obvious loss in grit emission (not measured). With all the other coals, however, efficiencies comparable with those obtainable on oil were attained, the best being 84 per cent (test 340).

7 ft Diameter Economic Boiler

Test No.	Fuel	Gross CV Btu per lb	Rank	Moisture (per cent)	Ash (per cent)	Volatile matter (per cent)	Fixed carbon (per cent)	Ash fusion temperature (°C)	
335	950 sec oil	18,517	—	—	—	—	—	—	
340	D	13,000	—	5·2	7·2	35·0	52·6	—	
341	E	11,990	702	11·0	7·2	32·2	46·6	1,160	
343	F	13,320	702	5·7	4·9	35·0	45·6	1,365	Stoker modified
345	G	12,610	802	10·9	3·2	32·6	53·3	1,310	
346	H	11,450	701	7·9	14·8	27·8	49·5	1,400	

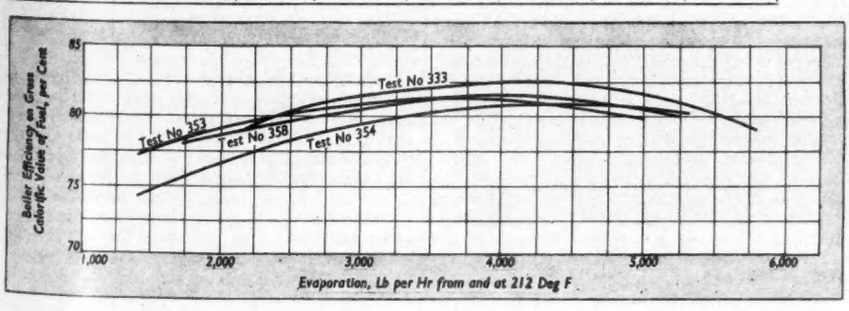


Fig. 4 (Left) Relationship between efficiency and load for 7 ft dia. Cochran Sinupac boiler on oil and different coals.

Conclusion

The results show that whilst the highest efficiencies were obtained on oil, good coal could achieve very nearly equal efficiencies when burned on modern firing appliances. Perhaps the main shortcoming in the performance of coal was its variability shown up particularly in Fig. 3 (tests 345 and 346). It was not an objective to recommend either fuel against the other.

It is suggested that two approaches could be made to overcome the difficulty: (1) Discover what factors in the coal cause the variation in performance, and then if possible eliminate these from the product marketed. (2) Design firing appliances which are insensitive to the particular coal characteristics discovered in (1).

To these points must be added those made under Section (2), viz.: (3) The development of means of handling coal in pipes. (4) Finding means of minimising the inconvenience of handling ash, grit and soot. (5) Improving automatic control for coal burning appliances.

It is known that work on many of these problems, is proceeding, notably in the laboratories of the British Coal Utilisation Research Association, but such work surely deserves much greater financial support than it appears to be receiving.

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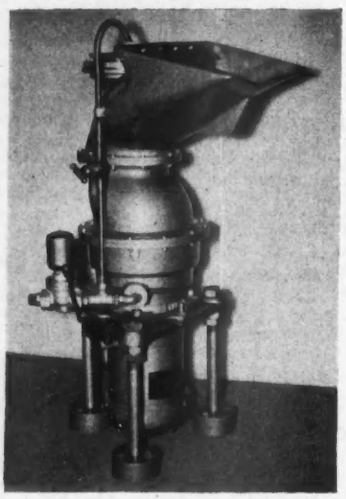
Design Departures and Components at Olympia

A SELECTION of some of the exhibits to be seen at the forthcoming Engineering, Marine, Welding and Nuclear Energy Exhibition is given on this and the facing page. Other plant, for the engineering user, showing at the exhibition, is described on pp. 527 to 532 in this issue. The exhibition, at Olympia, London, will open on 20 April and close on 4 May.

Heavy Duty Waste Disposer

A unique method of operation is said by the manufacturers of a new waste disposer machine to make it capable of handling many categories of waste materials, more than is usual for this class of machine.

Known as the Disposomatic, the machine has wide application in ships, hospitals, laboratories and many other places where large quantities of waste must be disposed of quickly.



Water jets speed the break-up of waste.

Powerful jets of water impinge on the teeth of the cutter ring from the periphery of the pulverising impeller. These jets speed the breaking up of the waste and also wash the machine clean after use.

Of general robust construction, all vital parts subject to corrosion are made of stainless steel. Cutting elements are of high grade steel to ensure long life and heavy duty roller bearings are fitted in the shock-resistant motor.

In the event of the impeller becoming wedged, a special releasing gear can be actuated through a bar engaging on a toothed wheel, ensuring adequate leverage to free the machine.

Powered by a 3 hp motor in either 200 or 400V, 3-phase for 50 or 60 c/s operation, it can be supplied for ac or dc currents. Various methods of installing the Disposomatic are available and the makers produce special hoppers and funnels for individual requirements.
Haigh Engineering Company Limited, Alton Road, Ross-on-Wye, Herefordshire.

Two New Belt Drives

Two new belt drives are available from William Kenyon. The first of these, known as the Powergrip Drive, is said by the makers to be exceptionally compact, and drives can be engineered at centre distances so short that the pulleys themselves are almost touching. Ratios of 12 to 1 can be achieved with little difficulty.

Apart from making possible absolute synchronisation of machinery, the drive ensures a smooth uniform motion which on production machinery contributes to quality finish. The belt itself is toothed and runs over grooved pulleys at speeds of up to 16,000 ft per min. It is said to be almost noiseless in operation, and the high tensile strength is obtained from steel tension members which form the load carrying elements.

The Powergrip is made in five pitches, and is suitable for applications of up to 600 hp. A complete range of taper bushed pulleys and belts is available.

Kenyon's other new belt drive incorporates the "Poly-V" belt which is a V-type belt of unitary construction but with 40 per cent greater power capacity than the standard V-belt. The new belt is said to eliminate the differential driving problem often encountered with standard V-belt drives and ensures smoothness of running.

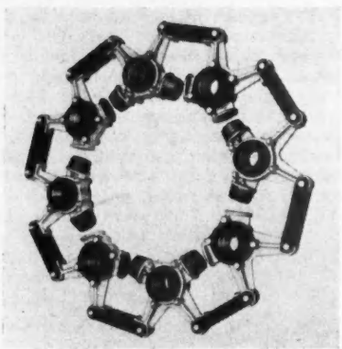
Capable of absorbing heavy shock loads, it is ideal for all heavy pulsating machinery. The drive is made in three sections and can cater for applications from fractional to hundreds of horsepower.
William Kenyon and Sons Limited, Dunkinfield, Cheshire.

Flexible Couplings for Marine Engines

The Torque Transfer Link Coupling is one of the range of Duolastik couplings developed by Metalastik as an economical cure for resonant torsional vibration in marine engine and propeller shaft systems and industrial drives. This coupling, which is said to be very flexible at low torque, stiffens rapidly at predetermined torque.

It can transmit 400 hp per 100 rpm and is suitable for engine speeds up to 600 rpm. It is 4 ft 7¾ in diameter.

In relation to their capacity and large torsional deflections, all four couplings in the Duolastik



Economical cure for resonant vibration.

range are compact and take up little space between the flywheel and gearbox. They are manufactured to Lloyd's requirements.
Metalastik Limited, Evington Valley Road, Leicester.

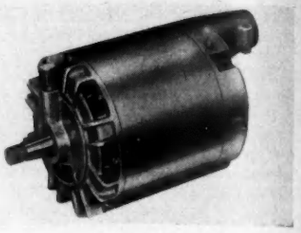
Better Battery Charging with AC Generators

Among the electrical exhibits which CAV are showing are 8 in and 14 in diameter ac generators for battery charging and lighting systems with suitable rectifiers and control boards. A 7 in diameter machine with built-in diodes is also displayed and is illustrated. These were described in greater detail on p. 492 last week.

The ac generator has certain advantages compared with the dc machine, particularly in applications where the prime mover operates at low speeds for long periods. It is capable of generating the whole or a substantial part of its output over a wide speed range, and can therefore maintain the battery in a satistactory state of charge even when the engine is idling. It is lighter and simpler in construction than a dc machine of comparable output and has no commutation problems.

A fully transistorised regulator for use with the 7 in diameter ac generator is to be shown. In this regulator a medium power transistor is connected in the generator field circuit in place of the conventional vibrating contacts.

The transistor is driven "on" and "off" by a low-power transistor which has a Zener diode in its base circuit. The switching cycle is initiated by the breakdown of the diode when



7 in diameter ac generator with built-in rectifier diodes.

the output of the generator reaches a predetermined value. CAV claim that the standard of regulation with this arrangement is very high, and is in all respects superior to that of the conventional vibrating contact regulator.

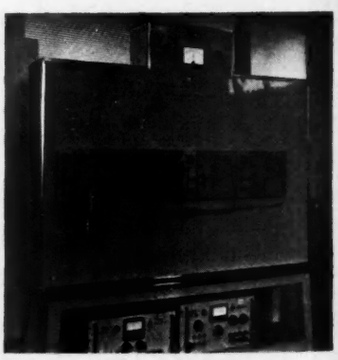
The output voltage is held steady, and change of voltage with temperature is negligible for all practical purposes. Absence of contacts and moving parts results in greater reliability and the need for less attention during service.
CAV Limited, Acton, London, W3.

Analogue Computer for the Classroom

An analogue computer has been developed to meet the present trend towards the introduction of computing techniques into the curricula of universities and technical colleges.

Although basically an educational instrument, its relatively high component accuracy—within 1 per cent—makes it suitable, for laboratory use in addition to classroom work.

The computer is unique, say the makers, in that setting up a problem automatically displays on the computer board visual presentation of the



Modestly priced analogue computer.

circuit diagram involved. The normal difficult transition from purely theoretical study to the operation of an advanced computer is thus alleviated.

The standard machine has a capacity of eight amplifiers, but provision is made for extending it to 15. It is designed for operation with independent power packs and oscilloscope as these are usually to be found in the average laboratory. They can be supplied if necessary.
Short Brothers and Harland Limited, Precision Engineering Division, Castlereagh, Belfast.

Reversible Locking Clutches

An addition to Renold's range of power transmission equipment is announced and will be on show at Olympia.

Known as the RL (reversible locking) clutch, it consists of a circular outer race containing two coaxial inner races which act as controller and follower. Two sets of special locking elements are mounted between the follower and the outer race, one set arranged for driving clockwise and the other anticlockwise. Slight angular movement of the controller actuates a set of shoes which unlock one or other set of elements, thus providing reversibility of drive.

The RL clutch, which has a high torque/size ratio, can be used as follows:

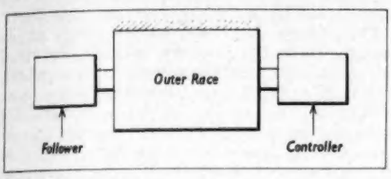
Position Control or Anti-Feedback.—With outer race fixed, controller can drive follower in either direction. When controller is stationary, the follower is locked in both directions. Typical applications include preventing torque feedback to control wheel on steering gear; positively holding hoists and lifts in the required position without external braking; and providing accurate setting for controls which cannot be disturbed by external forces (useful for, say, aircraft wing flaps or machine tools).

Reversible Backstop.—With the follower fixed, the outer race will lock or over-run the follower in either direction. A 5° movement of the controller reverses the direction in which the outer race freewheels. It can be applied to reversible machinery of all kinds as a safety device.

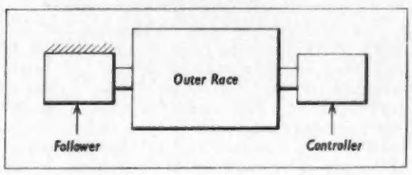
Six sizes at present make up the range of RL clutches, which are available with either ball or sleeve bearings. Outside diameters range from 37 to 160 mm with torque capacities from 6 to 2,500 lb-ft. Design sheets covering typical applications are also available.

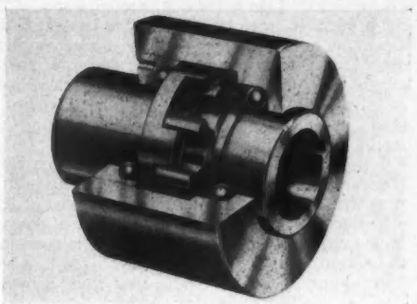
Renold Chains Limited, Wythenshawe, Manchester.

As position control or anti-feedback.



As reversible backstop.

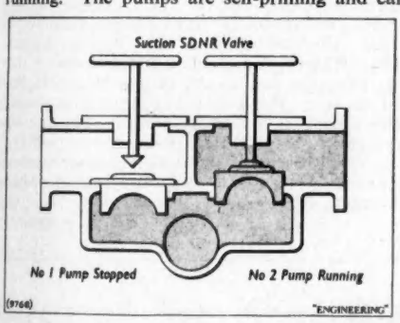




Rotary Gear Pumps Available as Multiple Units

Among the items to be shown at Olympia by Drysdale's is their "Axoil" forced lubricating pump.

Of the positive displacement rotary gearwheel type, a range has been developed specifically for marine services. They give continuous flow, without vibrations or pulsations and maintain their efficiency over long periods of continuous running. The pumps are self-priming and can handle oils with viscosities up to 10,000 secs Redwood No. 1. Five sizes are included in the range from 3 to 8 in with outputs of from 11·5 to 165 tons per hour respectively.



The vertical mid-mounted arrangement ensures the minimum use of space coupled with lightness and maximum accessibility. In addition to the basic mid-mounted pump the Axoil is available for bulkhead or wall mounting by a mild steel fabricated right-angled bracket, strut mounting by four tubular columns, and base mounting whereby the pump is mounted on a mild steel fabricated stool.

The pumping element consists of two pairs of rotors intermeshing with each other in the casing bores, with the oil flow in an axial direction from the inlet ports which are arranged at the ends of the casing to the centrally disposed discharge port. Suction and discharge branches are arranged on the centre line of the driving shaft so that the pump can be turned through 180° when the opposite hand is required.

Axoil pumps are available as twin and triple packaged units which comprise two and three pumps, one working and one standby, and two working and one standby, respectively.

Pump casing and top and bottom covers are in cast iron, while the rotors and shafts are of special steel. The rotors have helical teeth, the helices being opposed so that mechanical and hydraulic end thrust is eliminated.

A relief valve protects the pump from excessive pressure. It consists of a main by-pass valve in the pump casing, controlled by a small pilot valve.

The Axoil is also available as twin and triple "packaged" units comprising two and three pumps, one working and one standby, and two working and one standby, respectively. The pumps are mounted on common stools and are complete with screw-down non-return suction and discharge valves with associated connecting pipes and fittings. The arrangements are such that only one suction and one discharge pipe is required to be connected to the set. The packaged units are available with automatic control gear.

Drysdale and Company Ltd, Yoker, Glasgow, W4.

Roll Damping Fins for Small Ships

As those who have spent time at sea in small craft know only too well, their violent motion, even in quite moderate weather, can cause discomfort and exhaustion to passengers and crew, and occasionally the weather may be bad enough to delay the movements of the ship.

It was in an attempt to make small ships less sensitive to the effects of weather that the Vosper roll damping fins were first put on the market. They are designed to have a "low aspect ratio, meaning that they are fairly broad, but do not protrude beyond the limits of the beam and keel of the ship. In this way they offer no impediment to berthing or docking. Retraction gear is not therefore required.

Simple hydraulic devices power the fins which are controlled in their movements by a velocity-sensitive gyroscope. Installations have been designed for ships of 24 to 5,000 tons.

Vospers say that this equipment has given good results at sea, and both crew and passengers have benefited. In addition, ships' fittings and machinery can be more easily maintained.

Some thirty sets have been installed in ships and the British Admiralty have approved an alteration and addition for all operational coastal minesweepers to be fitted with this equipment.

At the Engineering, Exhibition at Olympia, Vosper will exhibit a full size top plate, which shows the latest developments and contains all the mechanism for operating the fin including automatic disc brake. A working model of a ship's engine room showing a complete roll damping installation in place will also be on show.

Vosper Limited, PO Box No. 18, Portsmouth.

(Above) A typical Vosper non-retractable roll damping fin. (Right) Fin top plate showing stock, rams and disc brake operating mechanism.

On the Shelf

By Frank H. Smith

ONE of my more jackpot-hitting paragraphs was that of 13 January where I felt sorry for remoter libraries because of the paucity of their resources. A fellow columnist (if I may so flatter myself), Mr. Bakewell, in the august *Library Association Record* for March, asks have I never heard of the Regional Systems, the N.C.L., the Science Library and Aslib? It is just because I have heard of them (N.C.L. outlier since 1922, Aslib member since 1924) and have to deal with their handouts after anything up to two months delay that I feel sorry for those librarians who cannot scout around the district with a telephone. All the same, I am grateful for Mr. Bakewell's kind opening stanza. Lazarus had nothing on me.

I think that all we who know it agree that Unilever's prestige magazine *Progress* is pretty near the top in its class, and it has shown further evidence of its topitude by producing a general index and index to authors and articles covering the period autumn 1948 (Number 220) to summer 1960 (Number 266). I note that their printers are "at the Butter Market, Ipswich"—which is pretty handsome as a gesture from the manufacturers of Stork. (Can *you* tell the difference—apart from its creaming?)

The H. W. Wilson Company (950 University Avenue, New York, 52) are specialists in the publishing of all-embracing indexes. Such titles as "Agricultural Index"; "Applied Science and Technology Index"; "Index to Legal Periodicals" and so on are all, no doubt, known in their specialist fields. A list, dated January, 1961, is available of the lot and the agents in Great Britain (I do not, you will note, say "in this country") are W. and R. Holmes, 3-11 Dunlop Street, Glasgow, C1.

Up from the bottom of my drawer comes *Soviet News* of 11 February with a publishing forecast of a 100-volume engineering encyclopaedia. It is to be done by the State Scientific and Technical Press for Machine Construction Literature, and that alone should take the best part of a catalogue card. There are to be five sections and machine design alone will take 20 volumes. The concluding section will be devoted to industrial management so that by the time the student has got to that bit he will be about ready to retire—or in his grave.

Not bad this. A letter dated 1 March, 1961, advises that the *Proceedings of the Second International Congress on Cybernetics* (Namur, Belgium) have just been published. The Congress was held in September, 1958. I always thought that cybernetics was tied up with efficiency and all that jazz, but if this is it give me the old days back again. Anyway, if you want to fork out 1,200 Belgian francs send them to Secretariat, Association Internationale de Cybernetique, A.S.B.L., rue Basse-Marcelle No. 12, Namur, Belgium.

A neat folder from the Cement and Concrete Association tells you all about their reference and photographic libraries. Write 52 Grosvenor Gardens, London, SW1, or 'phone BELgravia 6661. I still have a delightful collection of leaflets that I got from them before the war, showing me how to transform my garden into one of the stately homes of England with the aid of a bag of cement, some water, a spot of ballast and a bit of formwork. I never did get down to it though.

More straws showing the direction of a wind of change. The College of Aeronautics has changed the Department of Aircraft Economics and Production to the Department of Production and Industrial Administration; the Department of Aircraft Electrical Engineering to the Department of Electrical and Control Engineering; and the Department of Aircraft Materials to the Department of Materials. Can aircraft be on the way out?

Raising Steam with Maximum Economy

Boiler House Practice. By J. N. WILLIAMS. 3rd Edition. *Allen and Unwin.* (70*s*)

Steam raising using fossil fuels, which once exercised the minds and ingenuity of our greatest engineers and is still one of the most vital processes of industry, has no longer much glamour for the average young engineer, whose mind is probably fully occupied with thoughts of nuclear power, rockets, and so forth. Yet, to quote figures in the book under review, some 45 million tons of coal and 2¾ million tons of fuel oil are being used per annum by general industry excluding large users such as the Central Electricity Generating Board. The science of combustion and fuel technology and the development of up-to-date boilers, firing appliances, handling gear and control systems are thus vital to the technical progress of this country while being, also, fruitful fields for research study.

The third edition of J. N. William's standard work on boilerhouse practice since it was first published in 1953 must, therefore, be warmly welcomed if only because the author's enthusiasm for his subject, which makes the book so readable, must communicate itself to those many students who will find it an essential textbook, particularly those taking the courses in boilerhouse practice of the City and Guilds of London Institute, for whom the book was initially designed. The book should also be recommended as background reading to the general mechanical engineering student who may not otherwise realise the wealth of interest in this subject.

The book is much more than a student's textbook, however, and it attempts to cover the latest trends and developments in boilerhouse practice. It will be a valuable work of reference to anyone who has an interest in steam raising, from the engineer in charge of the boilerhouse to the executive to whom the boilerhouse and steam distributing system are responsibilities he forgets as often as he can.

It is in considering the impact of the book on these people that one can ask if it will bring home the essential trends in present-day fuel technology. Even when considering the normal industrial boiler plant (and leaving out the large water tube boiler where the technical problems are of a different order), should so much space be given to hand-firing when the virtues in economy, in complying with the Clean Air Act, in control, cleanliness and general "amenity" value of mechanical stokers have been so clearly established? The modern coal-fired boilerhouse can—in fact should—be a clean, self-operating, highly efficient piece of equipment and it may be worth emphasising that appreciable, though maybe not enough, research and development work is in progress to maintain the technology of coal utilisation at a high level.

For example, work by the British Coal Utilisation Research Association includes programmes on coal and ash handling, combustion control systems and on existing and more novel firing methods all aimed at making the coal-fired boilerhouse more automatic and mechanised. Possibly Mr. Williams would consider in his next edition giving more space to stokers—particularly the chain-grate—and to automatic combustion control in shell boilers, even if this means pruning the sections on hand-firing. A bibliography or, at least, some suggestions for further reading, would also be advantageous.

The changes since the second (1956) edition are important, covering, for example, the use of amines in water treatment, the occurrence of acid smuts in oilfiring and numerous other items, adding, all told, about 24 pages of text. The most important changes have been made in the discussion of the Clean Air Act and in the closing chapter. Both these sections are good illustrations of the author's forceful "down to earth" approach and are well worth reading.

One sentence in the "finale" is worth repeating in full: "When the economics of coal and fuel-oil firing for industrial boilers are considered, there is frequently a tendency to over-simplify the issue." Anyone who has listened to the many arguments on coal *versus* oil at technical meetings over the last few years may think this an understatement and Mr. Williams' comments on this issue, while they will not satisfy every protagonist, do help to keep things in perspective.

It is probably true that the choice of fuel used in any plant is primarily based on economic grounds—though often less tangible factors such as security of supply, tradition, fashion and local influences play a very important part. The job of the fuel technologist is to ensure that the customer uses his choice of each fuel to best advantage. This will require much concentrated effort from all concerned, and Mr. Williams has performed a valuable service to the industry at large in providing such a comprehensive source of information to form a basis on which to work.

G. G. THURLOW

Experienced Automata

Self-Organizing Systems: Proceedings of an Interdisciplinary Conference, May 1959. Edited by MARSHALL C. YOVITTS and SCOTT CAMERON. *Pergamon Press.* (60*s*)

Self-organizing systems are important because they comprise devices (or procedures) for achieving an optimum processing of a given input by making full use of prior experience. The detailed structure of the system required to deal with a given input situation can be built-up by, and need not be built-into, the system. But, despite their importance, it is not easy to establish a suitably rigorous definition of what constitutes such a system.

This volume is the second in a series of "International Tracts in Computer Science and Technology and their Application"; it comprises the proceedings of an interdisciplinary conference on the title subject held in May, 1959, and cosponsored by the United States Office of Naval Research and the Armour Research Foundation.

It is not at all clear from the discussion at this conference whether the various authors agree among themselves about any final definition of a self-organizing system. In short, it seems that to describe the scope of the subject is easier than to define it. An operational definition is often useful in these circumstances and a marginally acceptable description follows.

A system in the sense used here consists of a complete sequence of operations on signals emanating from the environment, that is, originating external to the system. For example, an automatically controlled chemical plant or a digital computer programme, would constitute systems in the present sense. (One sometimes wonders if a digital computer is *de rigeur*, if not essential, for this type of study).

Let such a system be isolated, presented with a typical input signal, and let the output result be assessed according to some figure of merit; if when the experiment is repeated the output is found to demonstrate a statistically significant improvement in performance then the system is said to be self-organizing. The basis of the self-organizing system is learning: the implication is that some permanent or at least more than transitory modification of internal structure or behaviour as a result of previous experience can be shown to occur.

The elements of a self-organizing system can thus be seen to be the central processing device itself (operating upon incoming signals), a unit

for assessing the merit of the output from the system, and a means of modifying system behaviour in a non-transitory way in response to indications of goodness of performance. It is often tacitly assumed that modification of behaviour is achieved by explicit modification of the structure of the system. This is only one of numerous tacit assumptions about self-organizing systems, some of which can be unduly restrictive.

For example, such a system is said to process its input in order to produce an appropriate output; but, may it not be that the system organization effected in achieving the required output is one important result in itself? This matter will be pursued at a later stage of this review.

The thirteen papers presented in this volume group themselves into four sections as follows: Perception of the Environment; Effects of Environmental Feedback; Learning in Finite Automata; Structure of Self-organizing Systems.

The choice of section titles throws an interesting light on the antecedents of these studies. The terms "perception" and to a lesser extent "environment" have strong biological overtones. Indeed one of the first examples of a self-organizing system which springs to mind is the human body (in homeostasis—adapting to the environment—and in many brain functions such as problem solving).

Certainly it is true that study of "natural" self-organizing systems such as animals and human beings has been the inspiration of many attempts to design automata, automatic data processing devices which "learn" to optimise their performance for any given task.

To take an example, consider a general digital computer programme which has been designed as a logical problem-solving procedure. The programme must allow the assessment of the merit of any particular attempt at problem solution and include a method for modifying or organizing the procedure accordingly. Clearly the success of this organization process depends upon the existence of a suitable plan of search for new methods of attack. The design of search procedures of this type is difficult.

It is therefore hardly surprising that a programme designer should dearly love to know how comparable human problem-solving activity is achieved. As a result, much attention has been given to the behaviour of the human brain in dealing with logical problems. However, as will be seen, this is only one of the aspects of behaviour in which the brain can be considered as a self-organizing system.

In this field of research the stage has not yet been reached when conference time is substantially occupied by pedestrian, if worthy studies; all the papers in this symposium are provocative and most are highly stimulating. In particular there is a brief but perceptive account of basic problems, an illuminating study of a learning classification device using a digital computer, and a very readable outline of recent information about the neurophysiology of the brain.

In an important paper, McCulloch discusses how to achieve reliability in performance of circuits built up of unreliable elements; here, the discussion specifically concerns the judicious use of redundancy in neuron circuits such as might be utilised in brain function. Also on biological matters, an account by Auerbach of tissue-cellular self-organisation in living embryos is of special interest. This worker reports experiments showing the reorganization of living embryonic cells into patterns which are clearly predetermined, this ordered reaggregation occuring after the cells have been completely separated and then remixed in a suitable culture medium. An important aspect of this study is the observation that a change in the environment (here, the culture medium) changes the type of reorganization effected after remixing.

Sensitivity of this type to the environment is of course one fundamental feature of all self-organizing systems. In a sense any system which organizes its response to the environment (modifies with experience its procedure of processing input signals) establishes a type of internal representation of relevant aspects of the environment. This concept appears in various forms throughout the present symposium.

It occurs in a discussion by von Foerster of the environments of self-organizing systems. This paper attempts to show, *inter alia*, that there are several requirements to be satisfied in order that a self-organizing system can be identified as such. The point is made that a self-organizing system can have no real significance except when the system is in close contact with an environment which possesses "available energy and order." In von Foerster's terms the internal self-organizing system "eats" internal order from external order; in so doing it establishes what has been called an Eigen-model of the environment, and the system tends systematically to improve this model or analogue. An analogue of this type is therefore a necessary byproduct of self-organizing adaptive processing and that this should be so is a vital concept. The engineering interest of course lies quite as much in the way the analogue is built up and the uses to which it can be put, as in the overall performance.

The "Eigen-model" or "internal-analogue" concept arises naturally when human neurophysiological systems are considered. In a paper on brain processes for the present volume, it is argued that the activity of creative thought corresponds to what is called "substitute exploration of a substitute representation of the environment." Here (many writers have drawn attention to the significance of neural analogue networks paralleling the external world) the emphasis is on exploratory trial of a task, using an internal model of the environment.

Such trials may be utilised to assist subsequent human "motor" activity in the external world especially if the model parallels the environment in a spatial sense. In the case of brain processes, it also seems very possible that the internal analogue of the environment which is built up is of primary importance to the activity of the human organism. We should further expect that the analogue may undergo continuous revision with experience. To this extent some processes of the human brain may represent self-organization of a very high order.

However, complexity of representation is not inevitable in the analogue developed by a self-organizing system. If the processes carried out by the system are elementary the organization of the system can be simple; the associated analogue of the environment will be quite rudimentary. But, rudimentary or not, the analogue certainly seems to be important in the case of the human brain. Perhaps this is true for automata also. It follows that a major field of investigation concerns the means whereby a given analogue, a necessary concomitant of a self-organizing system, can be elaborated from a simple starting point.

It is exciting to contemplate designing an "artificial intelligence," an automaton, which can be allowed to start by seeking simple goals and then perhaps by elaborating those goals, to achieve self-elaboration of its basic function. A device which can be set to work to solve a series of, say, geometrical problems, is interesting. But if the device is subsequently able both to pose and to solve new problems, it is on the way to establishing a complete geometry.

It is therefore hardly surprising that designers of learning machines should turn their attention to the successful techniques of the human system. Indeed, Alexander Pope's admonition, that the proper study of mankind is man, seems nowadays directed less to philosophers than to engineers.

B. McA. Sayers

Budget for Ambition and Prosperity

Financial Incentives for Management. By Richard C. Smyth. *McGraw-Hill, New York and London.* (66*s*)

Economic progress depends on the free play of the acquisitive instinct.

This proposition makes some people see red. They say that men ought to do their best from devotion to the community. Many do. But, to express it in extremes, a starving man has no margin left to cultivate his social instincts and, by and large, the better off a man is, the more can he afford to act from selfless motives.

You cannot found a Nuffield Trust, unless you have first made the money. Some people argue that hospitals, schools, and charitable trusts, should not be left to the vagaries of private initiative but should be in the hands of the state. Of course, there is scope for state action in these spheres. But it should be kept within limits. Because, paradoxically, the bigger the state's responsibilities, the more people's acquisitive, and the less their selfless instincts are, in fact, cultivated.

Nobody disputes that medical and educational facilities, pensions and national assistance, should be available for those in need, but where the state lavishes them on the electors, on the one hand, rising taxation undermines the ability of the individual to undertake his natural obligations, and, on the other, his acquisitive instinct, for ever bigger and better benefits, is quickened and his urge to cultivate his selfless instincts to aid, first, his family, and secondly, his neighbours, is weakened.

As to vagaries, those of the individual are under a mass of family and social pressures, whereas it is as hard to influence those of government institutions as it is to capture the rock of Gibraltar. It can be done, but it takes such effort that the ordinary citizen, without influence, finds it easier to try to placate officials than to control them.

In states in which the acquisitive instinct is held up to scorn, economic advance is slower, because instead of enlisting the interests of the masses in making themselves, and so the nation, richer, the pace is apt to be set by the slowest moving file in a government department. To insist that financial gain is an ignoble motive spreads the idea that industry and commerce, which should attract the best talent if the nation is to get rich as quickly as possible, are somehow anti-social, or at any rate less noble than public service. Government service and industry should regard each other as partners in a common task. Each is complementary to the other.

Wide publicity has recently been given to suggestions that heavy taxation is no disincentive and that business executives will be just as efficient irrespective of their prospects of increased earnings. One hopes, therefore, that equal publicity will be given to the factual evidence to the contrary offered in *Financial Incentives to Management*, a practical handbook, by Mr. R. C. Smyth, president of a leading American firm of business consultants.

A study of 41 representative American companies between 1939 and 1950 revealed that those which increased senior executives' compensation by over 80 per cent secured an average rise in net profit of 360 per cent. Where compensation increased between 50 and 80 per cent, profits rose 230 per cent, and where executive compensation was either increased only up to 20 per cent or not at all, profits rose only 118 per cent.

A study of 15 industries showed that those companies which paid executives the highest percentage of total payroll, earned an average of 17·2 per cent on invested capital in 1956. This is 40 per cent above the 12·3 per cent reported by the average of all companies in the

survey. Again, top-paying companies earned twice as much on invested capital as did the companies with the lowest executive pay, which reported a 7·6 per cent return on investment.

Mr. Smyth details various incentive schemes. His statistical analyses show that companies which pay bigger bonuses pay bigger dividends. On an average, American companies pay bonuses of 50 per cent of salary to their chief executive. At lower levels, bonuses range from 15 to 20 per cent. In the past, many companies paid a lower basic salary if a bonus was paid, but they found that this reduced incentives by making executives regard their bonuses not as extra rewards for better results but as part of their salaries which they have a right to expect.

Most companies determine the size of their bonus fund according to a formula. For example, American Ford allocate 6 per cent of the company's income before taxes, after deducting 10 per cent on total capital invested. The total bonus is distributed among a company's major operating divisions according to each division's performance; profits earned are usually the ultimate criterion, so that the incentive to increase efficiency in each division is strengthened.

Of course, payment of bonuses sooner or later provokes the cry "Is any man worth £24,000 a year?" Some shareholders argue that there should be a ceiling on individual bonuses. Mr. Smyth replies that a ceiling stifles incentive and thus nullifies the object of paying a bonus at all. The most responsible senior executives are those more likely to be affected by a ceiling than any others, yet it is precisely they who can do most to ensure bigger profits. It is not in the interests of shareholders to discourage these responsible chiefs.

Some shareholders urge that the payment of smaller bonuses would leave more for dividends, but this is debatable. For example, in 1955 General Motors paid the enormous bonus of $95 million to 13,284 executives. But with Corporation tax at 52 per cent, only $46 million of these $95 million would have been available as dividends, and probably only half of this would have been paid out. Each shareholder would therefore have received only about 8 cents more per share. If General Motors' bonuses still seem large, remember that the company has paid them from 1918, since when it has grown into one of the world's largest private firms, and shareholders have reaped handsome rewards from this growth.

Since tax takes 78·3 per cent of income in the highest American tax bracket, American companies have devised what, under United States law, are legitimate ways of making bonus payments which reduce taxable income. One, which seems worth investigating over here, is a share option scheme whereby an executive in, say, the 62 per cent tax bracket, is (with shareholders' approval) granted an option for five years to buy, say, 3,000 of his company's shares at $95 a share, selling on the market at $100. After three years, the shares may stand at $145 and the executive exercises his option and buys 3,000 at $95 at a cost of $285,000, which he then sells for $435,000. He has made $150,000 before taxes. If this $150,000 were taxed at 62 per cent, he would make $57,000. However, his $150,000 would be taxed at the maximum capital gains tax, at present 25 per cent, so the executive has made $112,500 clear.

One advantage of such schemes in these times of punitive income tax is that they enable an aggressive executive to accumulate a private fortune of his own. It is to nobody's advantage that companies should be managed by purely salaried staff, who have never had the formative experience of taking risks with their own capital. Salaried employees tend to follow a safe course and to lack the drive and imagination which starts up new enterprises, which add to the wealth of the nation and give it a thrusting dynamic economy.

JOSSLEYN HENNESSY

Making Sense of Company Structure

Exploration in Management. By WILFRED BROWN. *Heinemann.* (30*s*)

Ever since the Tavistock Institute of Human Relations began their research project with the Glacier Metal Company in 1949, both social scientists and industrial managers, in this country and in others, have awaited developments with eager curiosity. Dr. Elliott Jaques' books on *The Changing Culture of a Factory* (1951) and *Measurement of Responsibility* (1957) made history in the as yet little known field of industrial sociology and opened our eyes to what was going on at Glacier.

Exploration in Management by the chief executive of the company, Mr. Wilfred Brown, chairman and managing director, is, in a sense, a sequel to Dr. Jaques' books. But it is much more than a continuation of the report on a fascinating research programme, it is a complete description of the company's concepts and methods of organization and management written with great insight, frankness and indeed with courage. Unlike many managers, Wilfred Brown has never been afraid to commit himself to paper. He believes in family trees, charts and diagrams of all kinds to illustrate exactly the sometimes complex hierarchial positions and interrelated responsibilities in a large concern. The written instruction and minuted decision certainly create precedents and may cause embarrassment but they make for clear thinking and the gradual working out of a known and agreed policy. So far has this been followed at Glacier, that over the years they have formulated a long and detailed company Policy Document which is given in full as an appendix to the book.

The new book serves a double purpose. It is both a detailed exposition of one company's growth, development and present situation and it is also a completely new treatise on the theory of management. The subject seems to divide itself naturally into the magic number 3. All jobs of work can be resolved into "Make, Develop, Sell"; administration has three natural divisions: Personnel, Technical, Programming. At Glacier, too, the organization is divided into three "systems": the Executive, the Representative and Appeal and there are even three types of behavioural roles: Assumed, Extant and Requisite. Some readers may, at first sight, be a little alarmed by some of Mr. Brown's language. For example, he describes what he terms "contraction and looped instruction," and like Humpty Dumpty he may be suspected of paying certain words extra, for example, "legislation," which is here made to mean something rather different from the word in ordinary use. In fairness it must be said, however, that such slightly strange language is fully explained and indeed justified in giving us a vocabulary for a new theory of management (Appendix I is devoted to a glossary of technical terms).

The book is not made up of dull academic concepts and esoteric terms. Its most useful (useful both to the manager and to the teacher of management) contribution is perhaps the faithful practical illustrations which accompany every statement of principle, some of which are nothing short of brilliant. These ensure the books readability. In fact, even Alice would approve because there are both conversations and pictures, if charts and diagrams may be called such. It is impossible to mention in a review even half of the exciting ideas and explanations contained in this book but many readers will be especially interested in Glacier's wide and far-seeing interpretation of the personnel function which is given in some detail in one section of the book. Mr. Brown also has some original and pungent comments on the controversial figure of the supervisor.

Oddly enough, and no doubt wisely, the term "joint consultation" does not appear but we are exposed to a refreshing draught of clear thinking on what American textbooks call "participation," which will do much to dispel all too frequent clouds of sentimental misconception.

In short, this is not just another book on management, with every second word ending in "ation." It is a new theory of industrial? organization almost a catharsis, wrung out, as it were, from the toil, sweat and tears (if not blood) of practical experience.

MARY F. ROBERTSON

New Books

Industrial Architecture. By JAMES F. MUNCE, *F. W. Dodge Corporation, 119 West 40th Street, New York 18, New York.* ($14·75)

An analysis of the basic principles and of the developments in factory design in the United States, Great Britain and Germany, fully illustrated with plans and photographs.

D.H.: An Outline of de Havilland History. By C. MARTIN SHARP. *Faber and Faber.* (42*s*)

A fascinating and well-illustrated account of 50 years of de Havillands, from building buses, through two wars, to the post-war story of jet airliners.

Inertial Guidance. By CHARLES S. DRAPER, WALTER WRIGLEY and JOHN HOVORKA. *Pergamon Press.* (42*s*)

A descriptive treatise on the physical principles and engineering methods underlying the navigation and control of vehicles solely by means of signals from sensors that depend only on the inertial properties of matter for their operation.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Components

Bearing Repair Service. THE GLACIER METAL CO. LTD., Alperton, Wembley, Middlesex. Information on the service group, the standard range of bearing alloys, and recent developments. Brochure. 16 pp., ill.

Castor Wheels. SCAFFOLDING (GREAT BRITAIN) LTD., Willow Lane, Mitcham, Surrey. Castor wheels suitable for mobile access towers 4 pp., ill.

Tables of Weights and Sectional Areas. THE HELICAL BAR AND ENGINEERING CO. LTD. Technical data and tables on Helibond bar. 8 pp., unill.

Fittings for Copper and Polyethylene Pipes. PEGLERS LTD., Belmont Works, Doncaster. Compression joints for light gauge copper tubes (BS 659, 1955), underground copper tubes (BS 1,386, 1947) and plastic tubes (BS 1,972, 1953). Brochure. 48 pp.

The Reviewers

Mr. G. G. Thurlow, M.Sc.(Eng.), A.M.I.Mech.E., M.Inst.F., is superintendent, boiler department, at the British Coal Utilisation Research Association.

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Mr. Josselyn Hennessy, M.A., is an economist, broadcast commentator and London editor of the *Eastern Economist*, New Delhi. He is the author of several books, including *The European Common Market: What Will it Mean to You?*

Miss Mary F. Robertson is lecturer in social sciences at the University of Nottingham, a fellow of the Institute of Personnel Management, and a member of the BIM/MOE working party on management studies.

Marketing

A Good Beginning by Aviation Exports

EXPORT sales by the British aircraft industry have got off to a promising start. The industry's earnings overseas in January and February were £25·3 million, almost £2 million more than in the same period of last year.

Aero-engines accounted for £14·3 million of the first two months' total, four million more than a year ago. Canada, the United States, France and Italy were the leading customers for engines. For aircraft and parts, Canada, the United States, India and New Zealand were all important markets.

Vanguard sales and aero-engines going to Canada accounted for half the dollar earnings (equal to £11 million) and deliveries to the United States, chiefly aero-engines, made up the rest.

The January/February total is broken down by the Society of British Aircraft Constructors into the following details:

	£
Aircraft	6,058,284
Parts	3,679,047
New aero-engines	5,630,493
Engines other than new	4,547,499
Parts	4,100,135
Electrical appliances	525,481
Aeronautical instruments	579,108
Tyres	137,091

Marconi Cameras for Second Italian TV Channel

When the second Italian television service goes on the air later this year it will be using 17 Mark IV television cameras produced by the MARCONI'S WIRELESS TELEGRAPH Company. The order for the cameras has been placed by RADIO ITALIANA TELEVISIONE, who received eight Mark IV cameras last year in time for the Olympic games.

RAI, who will use the 17 cameras to enlarge the facilities of their studios at Rome and Naples, have 103 camera lines in operation—52 of these were supplied by Marconi, 18 by German firms, 17 from the United States, twelve from PYE and four by EMI.

Nuffield Exports by British Waterways

It is 49 miles from Cowley, Oxford, and 59 from Longbridge, Birmingham, to the city of Gloucester, better known for its Cathedral than its port facilities. But it is its port that the NUFFIELD ORGANISATION of the BRITISH MOTOR CORPORATION is utilising.

The Nuffield exports shipping department are using the port of Gloucester and the sixteen mile Sharpness Ship Canal as a new route through which to maintain regular supplies to their Morris and Riley distributor in Dublin. A weekly shipment of more than 100 knocked down units is sent through Gloucester, along the canal and so by sea to Eire.

So far the Nuffield Organisation has used two specially built coastal and canal vessels, the Oosterdiep, a Dutch ship, and the Reginald Kearon, which is Irish registered.

If a canal is to be made use of to help maintain the flow of vehicles from the makers to the distributors, it is important that it shall be free from certain disadvantages. The Sharpness canal has no locks at all and its only navigational hazards are mudbanks. It has the depth to take vessels of 11 ft draught.

From Gloucester to Sharpness is between four and five hours on the waterway. Sharpness across the Irish Sea to Dublin is another 20 hours.

Higher Power Costs in the North West

The NORTH WESTERN ELECTRICITY BOARD has introduced increased charges following the rises in the price of coal and in the CENTRAL ELECTRICITY GENERATING BOARD'S bulk supply tariff.

The effect of the North Western Board's tariff changes is to put up the maximum demand tariffs for commercial and industrial consumers by 5*s* per kW per year and all unit charges are increased by 0·1*d* a unit.

The domestic, farm, commercial and block tariffs will no longer include the 0·01*d* per unit rebate and all 1*d* a unit rates become 1·15*d* per unit.

The changes took effect from 1 April. The Board has calculated that its average domestic consumer uses 1,800 units each year and that the effect of the tariff revision will be an increase in such a consumer's power bill of 7*d* a week. For the small domestic consumer the raised charges will mean about another 4*d* a week on the bill. They will cost the home with "many domestic appliances" about 1*s* a week.

Two and half years ago the North Western Board were able to give consumers a small rebate. Since then the Board, which prides itself on being perhaps the leading Board in Britain for reducing unit operating costs, has cut its offpeak tariffs and these are not being increased. Coal costs, local rates, wages and salaries have all been rising sharply for the supply and generating industries.

Hydraulic Tipping Gear at Moscow Trade Fair

Preparations for the British Trade Fair at the Sokolniki Park, Moscow, are now far advanced in many of the 600 firms taking part. One of the latest to announce its arrangements is TELEHOIST, the Cheltenham hydraulic tipping gear makers. All their material, some specially produced for the Fair, is on its way.

Most notable among the Telehoist exhibits are to be the company's SL 8 tipping gear actuating a sectioned steel body, the Teleloader sack lifter, a number of axial piston pumps and industrial hydraulic control units, including the new Telepak hydraulic power pack.

WILMOT BREEDEN, with whom Telehoist are associated, are to exhibit on the same stand. Among the products being shown will be heat exchangers and hollow stator blades for industrial gas-turbines.

English Turbines for Canadian Power Station

Turbines for a power station whose power is to be fed into North America's first extra high voltage (460,000V) transmission system are to be manufactured by the ENGLISH ELECTRIC Company.

The contract for two 84,000 hp hydraulic turbines has been placed with the English Electric division of JOHN INGLIS, of Toronto, by the HYDRO ELECTRIC POWER COMMISSION of Ontario.

Design work and model testing is to be done in Britain by the English Electric hydroelectric division, at Netherton and Rugby. Work is starting immediately on the fixed blade propeller type units and manufacturing is to begin late in the summer.

Completion is expected towards the end of next year and the turbines will be installed at the Ontario Hydro's Little Long Rapids generating station on the Mattagami River, about 500 miles north of Toronto.

Flying Micrometers in £3½ Million Order

Design, production and erection of a scree ore treatment plant, a basic oxygen steelmaking plant and tin plate cut-up line are all covered by orders worth £3½ million placed with HEAD WRIGHTSON (AUSTRALIA) PTY Limited, a subsidiary of Head Wrightson and Company, by the AUSTRALIAN IRON AND STEEL Company.

The scree ore treatment plant is to handle 1,200,000 tons a year of scree deposits taken from the flanks of Iron Knob. It will have an output of 800,000 tons a year of concentrate, averaging some 60 per cent iron content. HEAD WRIGHTSON MINERALS ENGINEERING Limited, of Sheffield, are to carry out the engineering for this plant.

The contract for the basic oxygen steelmaking plant is the first export order to be obtained by a United Kingdom firm for a complete plant using one of the new oxygen steelmaking processes. To be installed at Whyalla, South Australia, this plant will have an output of approximately 500,000 tons of steel a year. It is to be engineered in Britain by HEAD WRIGHTSON IRON AND STEEL WORKS ENGINEERING, of Thornaby-on-Tees. Head Wrightson, in this scheme, are to supply two 100 ton basic oxygen furnaces with the oxygen lancing equipment, fume ducting and fume conditioning equipment, steel buildings, plant, and other equipment, including steel transfer cars.

Pinhole Detectors

The contract for the tinplate cut-up line is a repeat order. It is to be built to the designs of HEAD WRIGHTSON MACHINE Company, of Middlesbrough. A similar line went into production a few months ago at the Port Kembla works of the Australian Iron and Steel Company. At first the new line is to be used to enable steel strip of up to 40 in wide, in coils weighing up to around 20 tons, to be cut into sheets suitable for hot dip tinning. The line is designed to operate at speeds of up to 800 ft per minute.

Flying micrometers and pinhole detectors are to be installed near the entry and before the flying shear, which will provide for off-gauge sheets and those with a surface defect to be automatically rejected in the classifying and piling device which follows the shear.

Ultimately, this cut-up line may be used to take coils of steel strip which have been electrolytically tinned and cut them into sheets to meet the requirements of the canning industry.

Though the engineering for the whole of this line and some of the equipment will be by the Head Wrightson Machine Company, the greater part of the equipment will be produced in Australia. Equipment and services worth almost £1 million are to be supplied from the Head Wrightson works on Tees-side.

Marked Interest in Sydney Trade Fair

With this year's Sydney Trade Fair almost completely booked up a second Trade Fair has been announced for 1963.

The 1961 Sydney Fair (from 1 to 12 August) will include the familiar wide range of international trade fair exhibits, from the fashion and other consumer interests to power, electronics and agricultural machinery. The Soviet authorities have taken almost 30,000 sq. ft of space.

SPERRY GYROSCOPE, ROLLS-ROYCE, BRITISH ALUMINIUM, HOOVER, HAWKER SIDDELEY and D. NAPIER AND SONS are on the long and impressive list of British companies taking part.

But the United Kingdom placing on the list of nations taking part and the area of their stands is not particularly high. These countries are among those with national pavilions at the Fair:

	Exhibition Area in sq. ft
Austria	3,300
Belgium	3,200
Ceylon	1,500
China	1,000
Czechoslovakia	5,600
Denmark	3,300
France	15,000
West Germany	18,000
Hong Kong	2,000
India	3,500
Israel	1,000
Italy	20,000
Japan	10,000
Korea	400
Netherlands	3,000
New Zealand	3,500
Pakistan	300
Poland	1,076
Sweden	2,500
Switzerland	3,500
United Kingdom	4,000
USSR	30,000

British participation in the Fair is channelled through INDUSTRIAL AND TRADE FAIRS Limited.

New Bearing Factory in Staffordshire

The American owned FAFNIR BEARING Company, of Wolverhampton, is to have a new 60,000 sq. ft factory at Hednesford, Staffordshire, rehousing the workers of the existing Hednesford Fafnir plant.

The contract was approved in principle at the end of last month between Fafnir and SHEPLEY BOOTH AND ASSOCIATES, civil engineers, of Wolverhampton, Staffordshire.

The 20 acre site at Hednesfrd is such that the new works will be built on concrete piles sunk to a depth of 40 ft. Completion of the contract is expected by 1 November this year.

A high proportion of the products of the new Hednesford works when in operation will be exported. Exports are also part of the business of Shepley Booth who recently shipped buildings for a new oil refinery at El Salvador, Central America. The company's export business in packaged factory buildings is increasing rapidly.

Avery Universal Testing Machine

A product aimed at both engineers and scientists demands a unique approach to design and marketing to succeed.

THE Avery Universal Testing Machine is an engineering compromise. It reconciles the conflicting interests of the customer who thinks his own problem is different, and of the manufacturer, trying to standardise his product.

It achieves this compromise by unit construction, adopted by Avery to a limited extent in 1931 and extended fully when they introduced the present range of Universal machines six years ago. The name "Universal" denotes any testing machine capable of performing more than one type of test, generally tension, compression, bending and shear. Other types of testing—hardness, for example—demand a different machine. The use of unit construction in the current range may be said to have carried the "Universal" philosophy of versatility a stage further. The success of this policy is reflected not only in the steady increase in sales but also in the accompanying reduction in orders for specially designed machines. Furthermore, the price of a complete 100 ton testing machine today is less than it was 30 years ago, despite the change in monetary values.

The name Avery will be familiar to every reader. The business started as a small family concern in Birmingham to supply the local merchants with the simple hand-made weighing devices known as steelyards. It did not come under the control of the brothers William and Thomas Avery until 1818, but they had the energy and foresight to develop the business to keep pace with the industrial revolution in Britain, and the expanding market for weighing machines that it created. Removal to Soho Works, Birmingham, in 1895, for long associated with Boulton and Watt, enabled them to concentrate all their manufacturing capacity under one roof, and install new machinery.

Avery soon started making testing machines, in small numbers. The first ones consisted of a standard weighing machine with a straining unit added, and were used mainly for testing railway springs. Next came the single-lever machine, which appeared in both standard and special forms. A special 300 ton machine made in 1912 for Birmingham University is still in use today, testing machines being a hardy and long-lived race.

After the First World War, engineers generally began to recognise their value in providing data about the physical behaviour of various engineering materials, which gave testing machines a big impetus. The vertical compound lever type appeared in the early 1920's, and by 1928 a diverse range of Universal machines was on the market. Apart from the single and compound lever types, manual, hydraulic and electric drive was used in different models, covering capacities varying between 5 and 100 tons. Avery also offered a horizontal hydraulic machine going up to 300 tons testing capacity. Special machines, too, were well to the fore, and a noteworthy example was one of 1,250 tons capacity—the world's largest—supplied to Dorman Long in 1927 for testing the components of the Sydney Harbour bridge, also still in use.

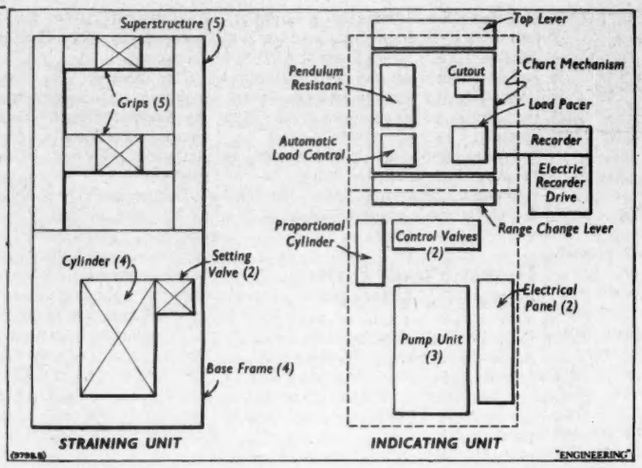


Fig. 2 Sub-assemblies from which the seven different machine capacities can be built. The figures in brackets indicate the number of different sizes of the same sub-assembly where more than one size exist.

Soon after 1930 an important design advance occurred with the introduction of the twin-cylinder hydraulic machine, arranged to transmit the load reading hydraulically and thus dispense with the weigh beam. A proportional cylinder was linked to a dial indicator, and the machine then became known as "self-indicating."

This arrangement has the disadvantage, however, that the use of two cylinders limits the range of capacities, since the crossheads have to be rigidly coupled and guided. In 1939, therefore, the single cylinder self-indicating machine made its debut, using an overhead cylinder arrangement. A vertical layout is preferable for any testing machine, except where the nature of the tests dictates otherwise; and nowadays all Universal machines are thus arranged.

During the early 1950's Avery found themselves having to make more and more special machines due to certain limitations on the part of the existing Universal range. Furthermore, a shortage of labour in the shops prevented the firm from increasing production to meet a rising demand for testing machines. They saw that redesigning the whole range of Universal machines was inevitable so as to take advantage of a greater degree of standardisation coupled with batch production.

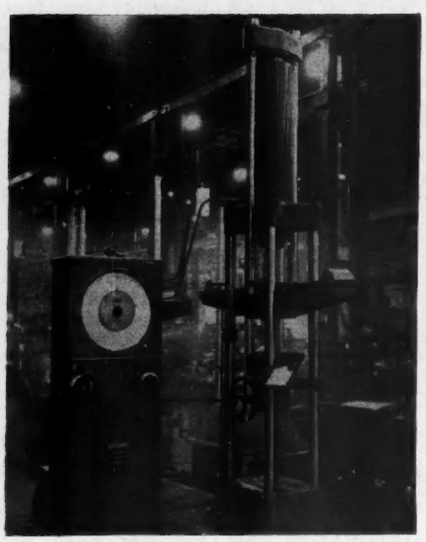


Fig. 1 The immediate predecessor of the 7110.

The concept of building up a range of machines composed of standard units had always been considered attractive, but had not been pursued earlier due to the obvious difficulties attending the scrapping of existing designs and starting from scratch.

Now Avery realised that it was no time for half-measures. They undertook a thorough investigation beforehand to ensure the success of the venture by study of their existing range. The new machines were taken as consisting of four basic unit assemblies: the straining or loading unit, the load measuring and indicating unit, the control unit, and the power supply unit. Such features as autographic recorders, load pacing equipment and automatic controls were treated as optional accessories.

THE NEW RANGE

The four basic units were then standardised so that they could be assembled with the other units in as many ways as possible, and yet cover the range from 500 lb to 250 ton capacities with only seven machines. ENGINEERING selected the 7110 of 25 to 50 tons capacity as the subject for this Product Profile because this machine probably represents the present best in the Universal philosophy. In common with the 7109 10 ton and 7104 100 to 250 ton machines, the 7110 has its straining unit separate from the indicating unit—though in the smaller sizes these are integrated. All seven machines were put on the market between 1955 and 1957.

The 7110's technical features are designed to meet the needs of both the works test house where routine material testing demands speed and accuracy, and the research laboratory where versatility and control are most important.

In designing the 7110, Avery specified the following features:

(1) A clearly marked load indicating chart, with a choice of ranges.
(2) Simple operation.
(3) Low floor space factor.
(4) Variable straining speeds over a wide range.
(5) Quick setting to enable grip holders to be respositioned rapidly between each test.
(6) Capability of taking autographic stress/strain records.
(7) Easy changing of specimen type or of nature of test.
(8) Capable of accepting a wide range of tools for special tests.

Additionally, a machine for research purposes will probably also require load pacing equipment, for applying load at a uniform rate (either

Fig. 3 Designed to perform before a critical audience—hence accuracy without fuss.

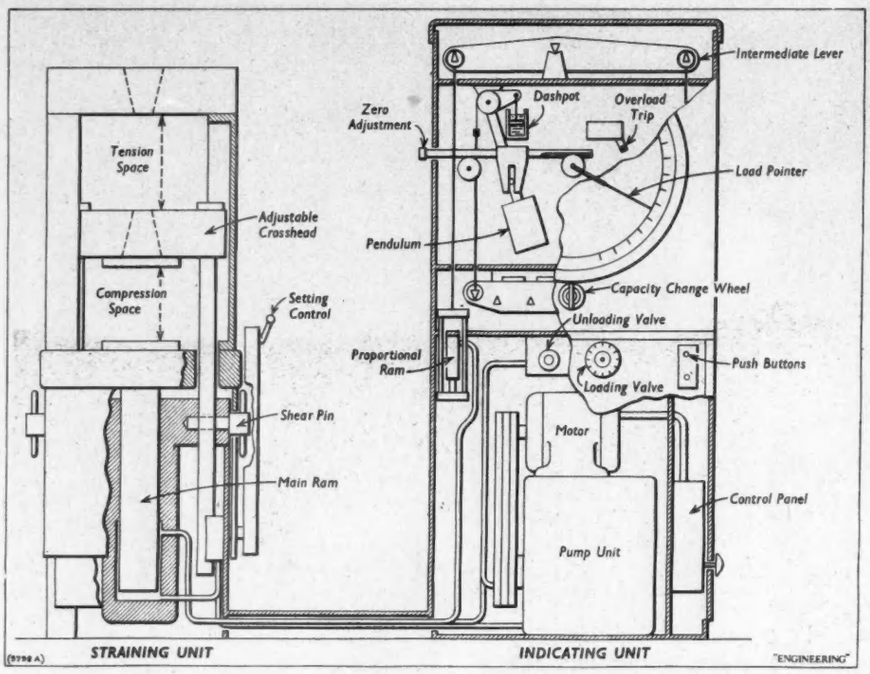


Fig. 4 Cutaway showing main features.

ascending or descending), for long-period load holding, for slow-speed load cycling, or for testing non-metallic materials such as concrete, plastic or timber.

In the 7110 it is possible to speed up repetitive testing by installing the pump of the bigger 100 ton machine. Conversely, for research work where the load has to be held for long periods, oil heating can be minimized by fitting the size smaller pump—with a reduction in speed. The ease with which changes of this nature can be incorporated to customer requirements has become a fundamental Universal characteristic.

Fig. 4 is a simplified sketch of the 7110 showing its working principles. The load is applied and measured by means of a main hydraulic ram which works without packing in an accurately bored cylinder. A controlled amount of oil leak ensures that the ram is fully lubricated whatever the load on the test-piece, and that the essential oil film is maintained. The hydrostatic pressure developed by the main ram is fed to a small proportional ram in the load indicator unit, also without packing, and rotated continuously to minimize friction.

This method of transmission of the load from the test-piece to the load indicator is inherently reliable and sensitive. Once adjusted and calibrated the machine can be depended on to maintain its initial accuracy for a very long period, and it is a rare experience to have to make any change when re-calibrating.

The force exerted by the proportional ram is transmitted through an intermediate lever to a capacity change lever having five alternative fulcra which are selected by a capacity change-wheel. Five capacity ranges are therefore available, from full load of the machine down to 1/20th load. The reduced force from the capacity change lever is transmitted to a circular drum axial with the pendulum shaft. This force displaces the pendulum, and the horizontal movement of the pendulum arm is translated into a linear movement of the rack and pinion mechanism, thus rotating the load pointer.

The pendulum mechanism is fitted with a dashpot, principally to damp the return movement of the pendulum when a specimen breaks. Since the mechanism is mathematically correct, it does not depend on non-circular cams or corrections.

The weight of specimen inserted into the machine is recorded on the dial, and particularly when heavy compression or transverse tools are used, it is necessary to reset the zero. The adoption of the pendulum system with a horizontal rack simplifies this operation.

Considerable thought has been given to the display of the chart numbering. As capacity is changed the correct numbers appear through circular openings provided in the chart. While a single ring of graduations would suffice, it has been found better to use three separate rings of graduations which can then be decimally sub-divided to suit the chart in use. Thus there is no ambiguity in the chart divisions, since each has a definite and clear value.

In common with the other machines, load pacing gear can be fitted to customer requirements

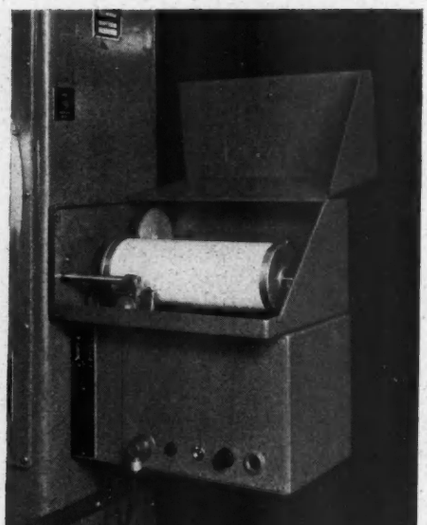


Fig. 5 High magnification autographic recorder.

to indicate that the load is being applied at the correct rate—an important factor when testing non-metallic materials. When fitted, there is an additional window on the chart, through which graduations on a disc concentric with the chart are visible. The rotation rate of the disc can be adjusted steplessly between 4 per cent and 100 per cent of one chart sweep per minute by means of a control knob. With the 7110, the indicating unit cabinet is large enough to accommodate the electronic controls for load holding and cycling, when they are required.

ACCURACY

Avery closely control the sensitivity, accuracy and calibration of all testing machines, both during manufacture and on completion. Each individual indicating cabinet is weighed off against deadweights to ensure that the pendulum and chart mechanism is free from error. Every completed machine is then calibrated over each of its chart ranges in accordance with the procedure laid down in BS1610, and complies with Grade "A," which means that for each chart range the accuracy is $\pm \frac{1}{2}$ per cent of the indicated load for loads exceeding 1/5th of the capacity of the chart in use. For example, a 60,000 lb capacity machine with a low load range of 3,000 lb × 5 lb, needs to be sensitive and accurate to 3 lb at the bottom end of the low scale range. This means a sensitivity and accuracy of 1/20,000th part of the capacity of the machine.

Testing machines, even more than weighing machines, are precision instruments and require regular skilled maintenance to remain fully effective. Avery have established a comprehensive service organisation, staffed with highly-trained men. They have thirteen service centres in the United Kingdom and many more in the Commonwealth. A school at Soho Works, where all their testing machines are made, is used for initial training schemes, courses on particular machines and also refresher courses. The longevity of testing machines is often something of a headache to the service department, due to the large number of types with which the service staff must be familiar.

Regular calibration checks are the most important service facility. Proving rings are used, to which the machine applies its load. Deflection of the proving ring with any given load is known and tabulated, and to ensure that the proving rings themselves remain reliable they are sent to the National Physical Laboratory every two years for re-calibration.

The testing machine division at Soho keeps a number of current machines set up ready for use as demonstration models. It also assumes responsibility for keeping in touch with universities and the NPL, and also attending technical conferences, in order that work for the future may be properly directed. Avery attach particular importance to the viewpoints and requirements of research establishments.

Market research in the accepted sense cannot apply to testing machines, as future requirements can only be determined by specialist engineers. However, testing machines have one factor at least in common with many other engineering products today: a growing tendency towards push-button operation.

The testing machine market is not one where a new concept can create business where none existed previously. Selling is generally to a customer already possessing a machine, which means that success is only achieved by maintaining and improving the existing markets. 1960 was a record year for testing machines, a clear demonstration of how Avery's planned expectations for the Universal machines have been realised.

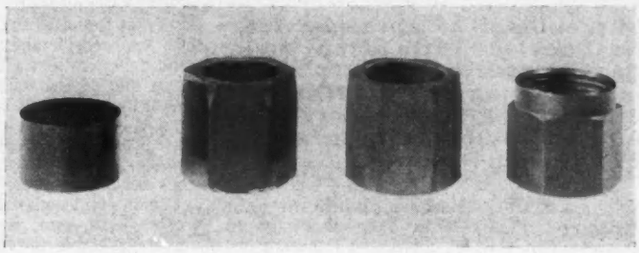
Cold Extrusion Technique for Titanium

New cold extrusion techniques have been developed for the low-cost manufacture of precision titanium fittings. The techniques were investigated and developed by the Battelle Memorial Institute, Ohio, USA.

A titanium part used successfully in a pilot run at Battelle was a hexagonal nut for aircraft-quality flareless tube fittings; normally produced in steel or aluminium on automatic screw machines. The production of titanium fittings by machining has previously been so costly that their use was unjustifiable; however, the new technique has cut these costs half.

Full-size hexagonal cups have been backward extruded, by Battelle development engineers, in a single operation from solid cylindrical unalloyed titanium billets of 1 in diameter and $\frac{5}{8}$ in thickness. The operation for this involved a 55 per cent extrusion reduction and required a pressure of about 335,000 lb per sq. in. The hexagonal cups, measuring 1 in across the flats by 1 in long with about a $\frac{3}{4}$ in bore were then finish machined and threaded on a screw machine.

Not only is the starting billet used in cold extrusion only half the weight of one needed for screw machining, but it can also be cut from a round barstock instead of the more expensive hexagonal barstock.



Sequence of operations in cold extruding and machining a titanium nut, (1) lubricated barstock slug, (2) extruded hexagonal cup, (3) vapour-blasted cup, (4) finished machined nut.

The material cost for one type of titanium nut produced by cold extrusion with screw machine finishing amounted to $0·64 compared with $1·52 for the same nut produced exclusively by screw machining operations.

Comparing overall manufacturing costs, preforming the nut by cold extrusion and finishing on an automatic screw machine yields a net cost saving of 48·5 per cent over the conventional method. According to Battelle engineers, other hydraulic fittings and female fasteners should be adaptable to fabrication from titanium by cold extrusion, thus making titanium parts more competitive with conventional metals.

In addition to significant cost savings in materials and labour, the new cold extrusion process offers the advantages of considerable strengthening through work hardening, good surface finishes and close dimensional control in the extruded condition.

Several years ago, Battelle demonstrated the feasibility of cold extruding titanium. The aim of the current development programme, however, was to establish the necessary basic technology for cold extruding actual parts from titanium on a commercial basis. The studies were directed mainly toward reducing the pressure requirements. The main variables studied were punch design, billet shape and lubrication.

Recording Instruments for Ramjet Engine

In a high-altitude test plant at Filton, Bristol, new instrumentation is being used to give research engineers an insight into the behaviour of ramjet engines for Bloodhound missiles. The Ramjet Development Department of Bristol Siddeley Engines Limited have commissioned a new type of multi-channel recording system, comprising 12 electronic strip chart recorders, supplied by Honeywell Controls Limited.

The parameters recorded on this equipment are fuel flow, temperature, thrust and pressure. The complete test run lasts for about ten minutes and recording proceeds for about two minutes. Digitising units are to be fitted to the recorders.

The first recorder shows primary fuel flow in the three alternative ranges: 20 to 200 lb per hour, 150 to 1,500 lb per hour and 1,200 to 12,000 lb per hour. The next instrument records secondary fuel flow in the alternative ranges: 60 to 600 lb per hour, 600 to 6,000 lb per hour and 3,000 to 30,000 lb per hour. A third instrument gives tertiary fuel flow. In each system, the metering is done by Rotameter flowmeters with remote-control valves interconnected with the flow range switches.

Blow-in temperature over the 0 to 500° C range is detected by a Hoskins chromel alumel thermocouple, and automatic cold-junction compensation is provided within a Honeywell instrument. The blow-in temperature is normally around 200 to 250° C.

Thrust and drag are recorded on two direct current energised instruments. The measuring unit is common to both systems and consists of a steel ring with two independent strain gauge bridges. Pressure is recorded on the remaining six instruments using ten balancing circuits which may be connected variously to recorders by jumper leads.

Constant-voltage stabilised units have been incorporated to energise the fuel flow transmission units, and thrust and pressure channels. Also incorporated in the scheme is a fuel flow timer for calibrating the fuel flow meters by measuring the time for a preset number of gallons to flow past the existing Avery-Hardoll precision bulkmeters.

Fuel flow and thrust recorders have several ranges and a range identification unit is included to emit various combinations of square-wave pulses to the marker pens of each recorder.

Analysis of Boiler Circulation

An extensive series of experimental investigations into the fundamental factors influencing the circulation process in high pressure boilers was recently reported to a meeting of the Institution of Mechanical Engineers in London.

The research project, the results of which are applicable also to other types of evaporative heat exchangers, was sponsored by the Water Tube Boilermaker's Association. The research was carried out at Cambridge under the joint supervision of a University Department of Engineering and WTBA panel.

Simple boiler circulation theory is based on the assumption that the steam-water mixture moves as a homogeneous fluid, but little data has previously been available on the effects of relative velocity between the steam and water phases, a phenomenon which is known to exist under real flow conditions in a boiler circuit. The paper which presented the results of this research was in three parts and was read by four authors*.

The first part described in full the construction and operation of the experimental plant, which was set up in 1954 on the site of a disused aircraft factory on the outskirts of Cambridge. It also contained a review of the instrumentation.

The second part gave an analysis of the experimental results obtained from measurements of the absorption of gamma-rays in their passage through the two-phase mixture at the outlet from the test section. The results from the gamma-ray equipment (in which the beam was provided by a radioactive isotope of caesium) enabled calculations to be made of the apparent density of the fluid mixture, and consequently of the respective velocities of the two phases at that point. Results of tests on horizontal and vertical $1\frac{1}{2}$ in and 1 in bore pipes were given.

Preliminary tests involving scans along a number of chords of the tube cross-section showed that the density distribution of the fluid was different with horizontal and vertical pipes. The data thus obtained from these and other tests was used to calculate slip correction factors, by means of which the acceleration and gravitational pressure crops—calculated according to the homogeneous theory—could be corrected for the effects of slip.

The third part of the paper presented an analysis of the pressure drop measurement made on the 1 in and $1\frac{1}{2}$ in bore pipes in the vertical and horizontal positions, with particular attention to the frictional pressure drops in the horizontal pipes. Comparisons were made between the experimental results, the values predicted by the homogeneous theory, and the values predicted after correction for the effects of slip by the methods outlined in part two.

In their conclusions, the authors pointed out that, over the range of variables covered in the tests, the experimental pressure drops at 2,100 lb per sq. in (abs) were close to the values predicted by theory for horizontal and vertical pipes.

For horizontal pipes at the lower pressures, homogeneous theory gave closer prediction of the pressure drop for heated than for unheated pipes, owing to the opposing effects of two-phase flow conditions on the frictional and acceleration pressure drops in the heated pipes.

For vertical pipes at the lower pressures, the experimental pressure drops were significantly greater than the values predicted by homogeneous theory. The gravitational contribution of the total pressure drop was dominant, and it was influenced significantly by the effects of slip. Closer prediction was obtained by the introduction of the slip correction factor described in part two of the paper.

* Haywood, R. W., Knights, G. A., Middleton, G. E., Thom, J. R. S., " Experimental Study of the Flow Conditions and Pressure Drop of Steam-Water Mixtures at High Pressures in Heated and Unheated Tubes," presented 29 March, 1961, Steam Power Plant Group, Institution of Mechanical Engineers.

Studies of Abrasive Wear Resistance

The subject of abrasive wear has received little attention in British laboratories. To assist in remedying this, the National Engineering Laboratory has embarked upon a programme of abrasion research.

IN DESIGNING a machine element to resist abrasive wear, it is often necessary to consider a number of conflicting requirements. The machine component may, for instance, not only have to withstand abrasion, but also high shock loading, fatigue stresses and perhaps even a corrosive environment. The final selection of a material must inevitably be a compromise solution under such conditions.

In an attempt to solve the problem of defining the conditions under which the various forms of abrasive wear occur in practice, Avery[1] has suggested that the following form of classification should be adopted, namely that three types of abrasive wear exist: (1) gouging abrasion, i.e., abrasion associated with high impact stresses, (2) high stress abrasion, and (3) low stress abrasion or erosion.

It is important to recognise that each of these three forms of wear may require the choice of different classes of materials for its solution and that the most suitable material for one of these types might be distinctly inferior if used under the conditions associated with the other two forms of abrasion. It is easy to see, for instance, that gouging abrasion will require the selection of an extremely tough material and for this reason the austenitic manganese steels are a popular choice. Such materials, however, do not possess a particularly high abrasive wear resistance, especially if very hard abrasive minerals are involved. Perhaps the most wear resistant materials that fall within the first class are the sintered tungsten carbides and the high chromium white irons, but both these materials must be well supported on a tough steel backing if high impact stresses are expected. When used in this way, these materials may snow at least a tenfold improvement in wear resistance over the austenitic manganese steels. Sintered tungsten carbides are largely used, however, for such components as rock drilling bits and other applications where small areas of wearing surfaces are exposed to extremely severe abrasive conditions, while high chromium irons are particularly useful in the form of welded hard facings for such applications as impact pulverisers or, as castings, for chute liners handling coarse abrasive ores.

High stress abrasion conditions refer to those situations where the applied loads are sufficiently high to cause fracture of the abrasive grains. In general, the actual wear rates per unit area may not be particularly high, but in many applications the surface areas involved are so large that the total amount of material removed is often considerable. In ore and mineral grinding operations, for instance, it may represent one of the major items of expenditure. Again, the most wear resistant materials for this class of wear problem are the high chromium white irons, but in many cases the martensitic high carbon Cr-Mo steels or the Ni-Cr white irons are chosen in preference.

Under conditions of low stress abrasion or erosive wear, high impact stresses are usually absent and this permits the use of relatively hard and brittle materials. One again finds that the high chromium white irons are extremely good, but the superiority previously shown by the martensitic Ni-Cr white irons over a straight pearlitic, low chromium, white iron is no longer so obvious, and the martensitic high carbon steels are even often inferior. It is also important to realise that materials, such as rubber, are particularly effective under low stress conditions. This is due to the fact that they possess such a low modulus of elasticity that no permanent damage may be done by an impinging abrasive particle. This observation led Oberle[2] to suggest that a criterion for wear resistance might be the ratio of the hardness, H, to the modulus, E, since this ratio, which is called the Modell, represents the strain that can be accommodated before plastic flow takes place.

Many of the applications so far discussed refer to machine components that come into contact with relatively large masses of abrasive material, but there are many engineering applications where this is not so, as, for example, in the case of lubricated journal bearings. In an application of this type, it is the usual practice to employ a hard and soft bearing material combination, as in this way one can ensure that the system will rapidly establish the most favourable geometry for efficient hydrodynamic lubrication. However, a bearing combination of this type also provides a considerable degree of protection against abrasive wear, since fine particles of abrasive matter upon entering the bearing are rapidly absorbed into the softer of the two bearing surfaces and are hence rendered innocuous, until the bearing's absorption capacity is reached.

Significance of Hardness

The fundamental problem of why one material should possess the ability to abrade another has still not been satisfactorily explained. It is not known, for instance, why in the case of minerals it is essential that there be a small finite difference in the hardnesses of the two components before one will scratch the other. This observation forms the basis of the Mohs hardness scale, which consists of ten different minerals arranged in ascending order of hardness and so chosen that each mineral is just capable of scratching the other that precedes it in the scale. Indentation tests have shown that each interval on this scale corresponds to an increase in hardness of 60 per cent. Tabor[3] examined the possibility that this scale might not be complete, since it seemed plausible that other minerals might exist which would enable the scale to be subdivided into even smaller intervals. He used a range of steels for this investigation and concluded that a fundamental hardness interval did exist, but that it corresponded only to an increase in hardness of 20 per cent. Even so this represents a considerable fractional increase. Tabor's experiments were not exhaustive, so that his conclusions may not be generally applicable to all classes of materials, but it does seem certain that some hardness interval must be exceeded before one material will scratch another. The physical significance of this interval, however, requires further investigation and now forms part of NEL's research programme.

The effective abrasion wear resistance of any selected material will be determined by its position on the Mohs hardness scale relative to that of the abrading mineral. If the latter has a hardness corresponding to a point low down on the scale and the material being examined has, say, a hardness of 400 kg per sq. mm, then it will appear to be highly wear resistant to an observer. The situation would obviously be reversed if the mineral was high up on the Mohs scale. The exact nature of the relationship is of some importance and a typical plot taken from a paper by Wahl[4] is shown in Fig. 1. It will be seen that the curves form a series of step functions, but the discontinuity, which occurs in the region where the material and mineral hardnesses approach one another, is not particularly sharp. Unfortunately, it is not possible to determine from this plot the exact position where damage just occurs, so that one cannot use it to check the validity of Tabor's conclusions.

It is of interest to note from Fig. 1 that the wear rates both before and after the transition are approximately constant and independent of the hardness of the abrading mineral. This will mean in practice that if the mineral is extremely hard, then little advantage will be gained by increasing the hardness of the material unless it can be made to exceed that of the mineral grain itself. Again these curves illustrate quite clearly why the relative wear resistances of different materials are often very sensitive to the particular hardness of the abrading medium.

Laboratory Testing

Numerous laboratory wear machines have been developed for the investigation of abrasive wear in all its forms, but interest has recently centred around three basic types of machine. The first of these is the Brinel type of abrader, which consists of a rotating cast iron disc against the rim of which is loaded the specimen material under investigation, see Fig. 2a. Abrasive material is allowed to enter the contact region and is carried between the surfaces by the rotation of the disc. In this design of machine, the contact stresses on the individual grains of abrasive are high and fragmentation readily takes place, however, this can be avoided by placing a hard rubber tyre around the rim of the disc. In this modified form the loading conditions may be considered to approach those more usually associated with erosive wear.

Another machine which imposes only relatively light loads on the specimen and also allows loose abrasive material to be used, consists of a spinning rod which rotates in a container filled with the abrasive material, see Fig. 2b. This machine has the particular virtue that it can be used to study wear caused by both wet and dry abrasive minerals, but the wear rates with this

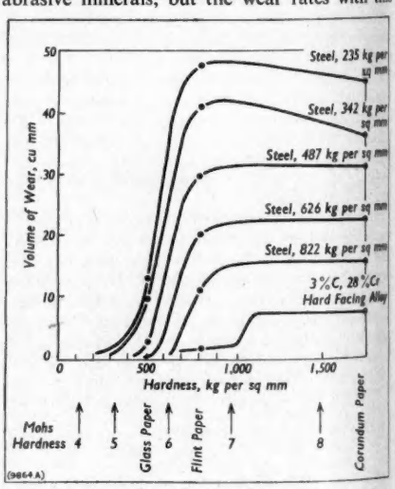


Fig. 1 Wear of several metals against hardness of abrasive.

Research Report

on the work of the

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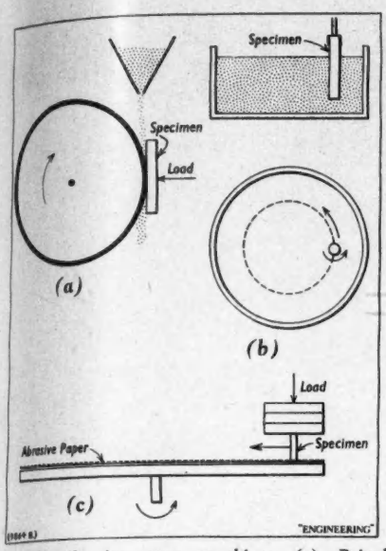

Fig. 2 Abrasive wear machines, (a) Brinel, (b) spinning rod, (c) pin-on-disc.

machine are usually rather low and long periods of testing may be required.

The most useful machine that has so far been developed, and one which is particularly popular in Russia and Germany, is the pin-on-disc machine, see Fig. 2c. In this machine a small pin, usually about 2 mm in diameter, is caused to traverse an Archimedean spiral path over the surface of a piece of rotating abrasive paper. For this test the grade of the paper that is used is of some importance and must not be too fine otherwise spurious effects, arising from the loading of the paper with abraded metal, may occur. It is generally found that with the above diameter of pin, the most suitable abrasive grain size to use is close to 70 microns. To avoid errors arising from variations in the abrasiveness of the paper, it is customary to "calibrate" the paper by using a standard material which is allowed to run over the same distance in an adjoining zone on the paper. Khruschov,[8] who has used this machine extensively for his numerous investigations, uses a standard material consisting of a lead-tin alloy.

Interpretation of Data

Although wear diagrams of the type shown in Fig. 1 are the most informative, recent research in this field has been concentrated upon examining the abrasive wear resistance of materials against minerals of very high hardness. The results of these investigations correspond therefore to the information contained in the right hand portion of Fig. 1, and may be considered to represent the intrinsic wear resistance of the material. In general, this type of experiment tends to group all materials into a rather narrower range than might be experienced in practice, so that some care is required in the subsequent interpretation of the results.

Most investigators have expressed wear behaviour directly in terms of a weight or volume loss, but a much more useful criterion to use is the expression "wear resistance," which is defined as the reciprocal of the wear volume. Khruschov, himself, uses the term "relative wear resistance" which is given by the ratio $\epsilon = \Delta l_S/\Delta l_M$, where Δl_S and Δl_M refer to the changes in length of the standard alloy and the material under investigation, when abraded for a given distance. When such an expression is plotted against the indentation hardness of a material, then the wear resistance diagram, as it is called, reveals a distinct pattern of behaviour for a wide range of materials, see Fig. 3. The first point to note on this diagram is that all technically pure annealed metals lie very close to a single line and indicate that a direct proportionality exists between the relative wear resistance, ϵ, of materials and their hardness, H. The constant of proportionality representing the slope of the line appears to be the same for both pure materials and those containing various amounts of impurity. Even annealed steels fall on this line according to Khruschov, but it should be mentioned that unpublished work carried out at NEL has not been able to confirm this result and slight departures from proportionality have been recorded.

When a carbon steel is examined in a heat treated condition a linear relation between ϵ and H is also found, but the slope is appreciably less than that observed for the technically pure annealed materials and the line does not pass through the origin, but through a point representing the same steel in its annealed condition, see Fig. 3. This latter result is somewhat surprising, since the structural conditions of a carbon steel, as represented by the various points on such a line, range from a fully martensitic state to a sorbitic and finally a pearlitic condition. The wear resistance associated with these various structures can be represnted by a single relationship of the form $\epsilon = \epsilon_0 + C(H - H_0)$, where ϵ_0 and H_0 are the relative wear resistance and hardness of the annealed steel. C is a constant of proportionality which increases with increasing carbon content and carbide forming elements. It is interesting to observe that, in every case, the increase in wear resistance attained by heat treatment is always less than that which is shown by a pure material in the annealed condition possessing the same indentation hardness

The effect of cold work hardening is especially revealing for it clearly shows that, under conditions in which the abrasive is very hard, the wear resistance of all materials is independent of the degree of work hardening to which the material has been subjected. In some cases the wear resistance may even show a decline. The explanation of this observation rests upon the fact that during the cutting action of the abrasive grain, the material is strained to such an extent that any preliminary work hardening has no effect on the amount of metal that will be removed. A particularly interesting case arises with the austenitic manganese steels, since Khruschov has observed that the measured wear resistance of this material is also independent of its previous work hardened condition, see Fig. 3. This result is most unexpected since this material can be hardened up to four times its original quenched hardness and would appear to indicate that the martensitic transformation, which is believed to occur during work hardening does not in fact take place. If it had occurred then an increase in wear resistance of the same order of magnitude as that shown by the fully hardened steels might have been expected.

It should be emphasized at this point that the above results only refer to the experimental condition in which the abrasive grains are very much harder than the fully work hardened state of the materials. For evaluating the practical wear resistance of metals, it is equally important to observe that the threshold mineral hardness at which wear first becomes evident, may have a dominating influence on the amount of wear that actually occurs. From Fig. 1, it appears that the threshold hardness corresponds closely to the indentation hardness of the materials examined, but whether or not this threshold limit is sensitive to the state of work hardening is not known. It seems reasonable to suppose that it is. Certainly the upper "knee" of each individual curve shown in Fig. 1 must correspond to the fully work hardened condition. If these deductions are correct then the shape of the wear versus hardness curve will depend upon the previous history of the material and fully work hardened materials should show a steeper slope in the transition region.

These conclusions, if substantiated, may explain the somewhat contradictory evidence that is available concerning the wear resistance of the austenitic manganese steels. Thus, although these materials undoubtedly have a relatively poor abrasive wear resistance when extremely hard abrasive grains are used, their ability to work harden to a very high degree may mean that the threshold hardness at which wear

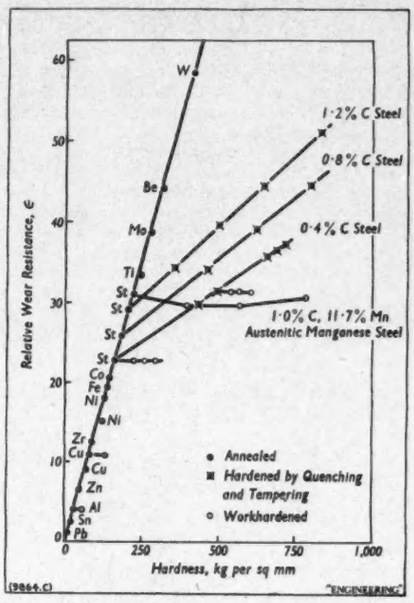

Fig. 3 Relationship between wear resistance and hardness.

just occurs is very much further displaced to the higher end of the Mohs scale than it is, for instance, in the case of a carbon steel. In the presence of an abrasive which has a hardness intermediate between the two threshold levels, the austenitic manganese steel may be expected to show a much superior wear resistance.

In the above mentioned diagram, the relative wear resistance, ϵ, as determined by very hard abrasive grains, can be regarded as a measure of the strength of the metal in its maximum work hardened state. The hardness, H, on the other hand, represents the resistance of the material to plastic flow when the degree of the latter is low. Thus, the ϵ, H plot represents two strength characteristics, a limiting characteristic, ϵ, and a characteristic, H, corresponding to a low degree of plastic deformation. Khruschov[6] shows that a plot of the true tensile strength at the moment of rupture against yield strength bears a remarkable similarity to an ϵ-H diagram.

This last example represents an attempt to seek a correlation between wear resistance and some bulk property of a material. However, abrasive wear is essentially a micro-deformation or cutting process and it would seem to be more reasonable to seek a correspondence between wear resistance and the properties of the individual components of the metal structure. In this respect, it has already been shown that the wear resistance of certain two phase systems can be determined from a knowledge of the wear resistances of the individual phases. In fact, the rule that applies is simply one of addition, if the different volumetric proportions of the constituents are taken into account. A remarkable example of the application of this additivity rule is in the case of the hyper eutectic binary aluminium silicon alloys. However, in other cases, some arbitrary weighting factor has to be applied. In the case of unalloyed cast irons, it is often possible to deduce the wear resistance merely by assuming that the graphite flakes act as voids in the lattice.

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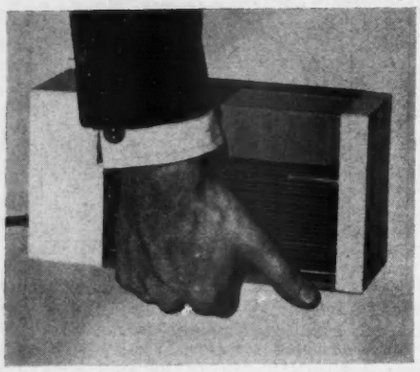
Fan Heaters Go Small

ONE of the first results of the development of the tangential fan has been the introduction during the last few months of small size fan heaters of high capacity.

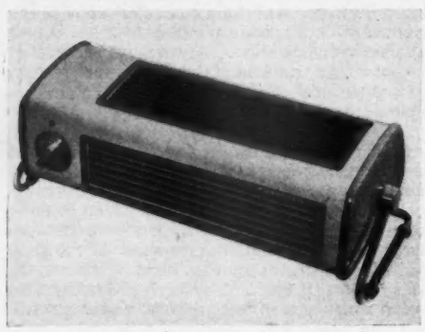
The principle has been developed by the German engineer Nicholas Lang using a fan approaching the paddle wheel type. A multi-bladed rotor (which has the blades parallel to the axis) is set at the exit of an air duct in such a way that when it revolves a cylindrical vortex of spinning air is set up inside the fan blades



The Braun Turbo Heater rated at 2 kW is small enough to be carried in the hand.

with its axis parallel to that of the fan. This vortex draws the incoming air into the rotor at a speed far higher than that of the blades, and ejects it in a fast smooth stream many times faster than the peripheral speed of the fan.

Since fan noise varies as the 5·5 power of the speed, the reduction of the peripheral speed by a factor of ten, as compared with an axial fan of the same capacity, makes for a quiet running



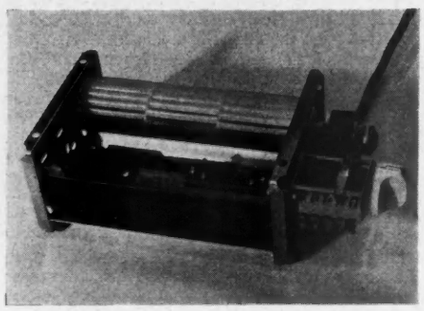
The Hanovia Turboflo is rated at 3 kW but is still a remarkably small unit.

unit. The efficiency is of the order of 60 per cent as against 3 per cent for the axial fan, so that the size can be enormously reduced for the same output. As a result the physical size of the heaters has been reduced while retaining high electrical loadings.

The model shown in the first illustration is the Braun, handled in this country by the Brattel Electric Company Limited, 1 Dover Yard, London, W1, which although small enough to be carried in the hand is rated at 2 kW. A rotary switch on the Turbo Heater gives a choice of fan only, medium or strong, and three heats of 500W, 1,000W or 2,000W. A thermostat is included and a safety cutout incorporated so that if the outlet is choked or the fan stalled by accident, overheating will not occur. The air stream travels a long way before becoming dissipated in the room, which is one of the features of the type and makes for rapid heating even of large spaces.

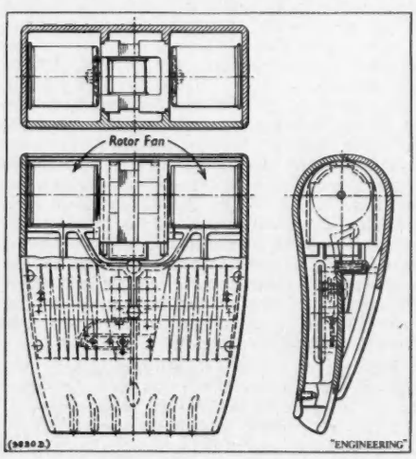
The Turboflo shown in the second illustration is by Engelhard Hanovia Lamps, Bath Road, Slough, Buckinghamshire. This has a higher rating at 3 kW and delivers about 70 cu. ft of air per minute for a fan speed of 1,150 rpm maximum driven by a Garrard motor. It has a six position control switch for fan alone and choice of heats. A safety cutout is set to operate at 55° C in the case of obstruction to the air flow. The cutout is self-resetting when the unit cools down again. A red pilot light shows that the heater is connected to the mains supply. The case, which measures 19 in by 8 in by 6 in high, is made from plastic coated sheet steel finished in two tones of grey.

A unit using the same fan principle but with modifications to other parts is that being produced by Solartron Electronic Group at Farnborough, Hampshire. Built into a fan heater it is about the same size as the Braun and has a throw of about 15 ft, but the makers envisage it being incorporated in many different styles of case and in many different applications. For this reason it is being produced as basic unit. A particular feature is the heating element which is formed of metal ribbon wound on edge in a helix, making it very robust. It is supported on an insulating cradle so that it cannot collapse at any temperature.



The Solartron basic unit can be incorporated in a fan heater or used as a built-in heater.

The last illustration shows a possible development of the tangential fan in the form of a hair dryer no larger than the average electric shaver. Other applications envisaged include a vacuum cleaner without a hose and not much heavier than a broom; a silent car heater; and cooling fans for projection equipment where silence is essential, and space is severely limited. The basic unit has a shaded pole motor with a temperature resistant plastic rotor, together with a heat exchanger and a thermal safety cutout.



The small size of the tangential fan would permit a hair dryer to be no larger than the average electric shaver.

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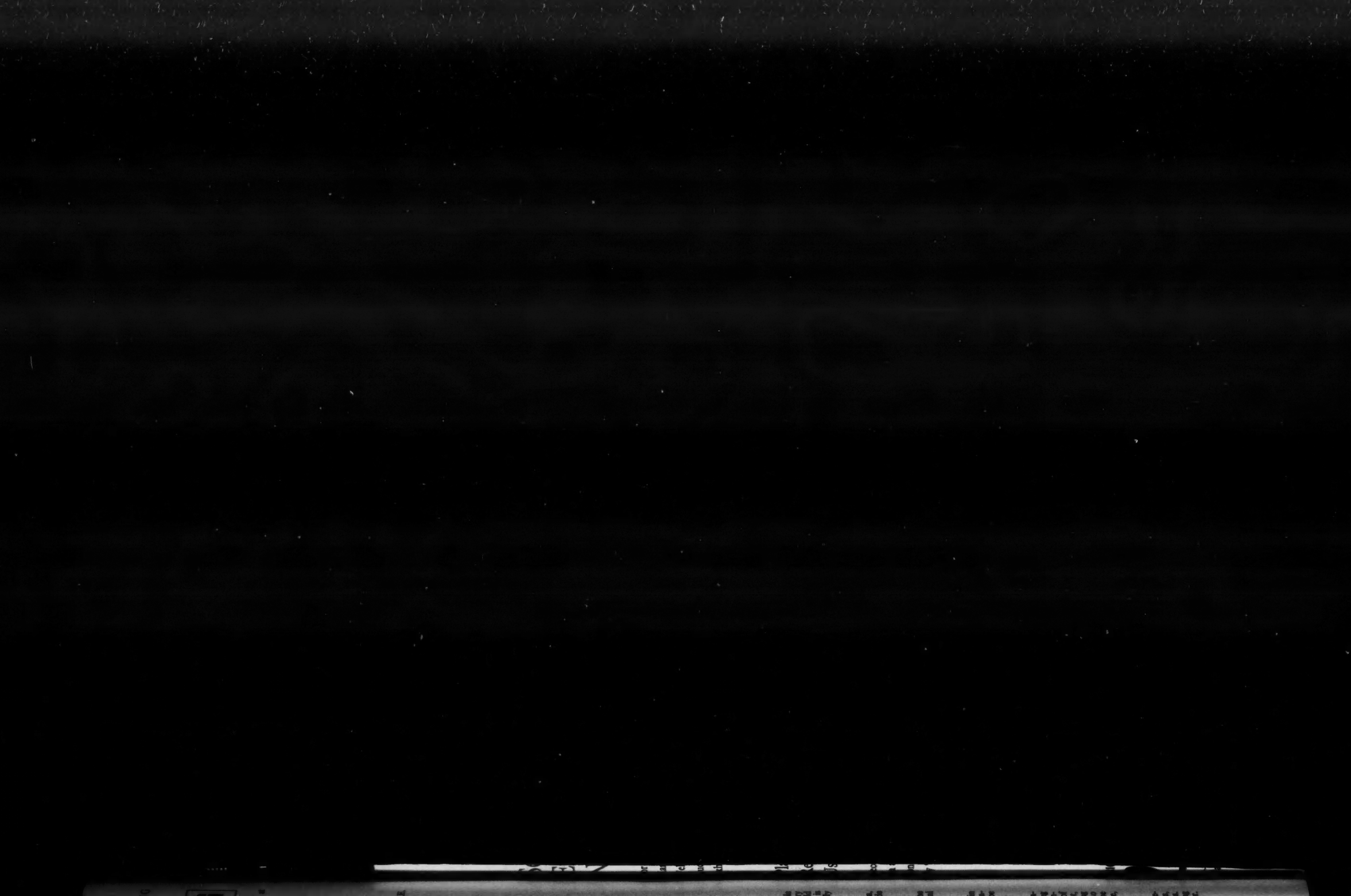
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